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AN URBAN INSTITUTE PAPER ON HOUSING

Simulating the Housing Allowance Program in Green Bay and South Bend

A COMPARISON OF THE URBAN INSTITUTE HOUSING MODEL AND THE SUPPLY EXPERIMENT

JEAN VANSKI
LARRY OZANNE

INTEGRATED ANALYSIS, EXPERIMENTAL HOUSING ALLOWANCE PROGRAM
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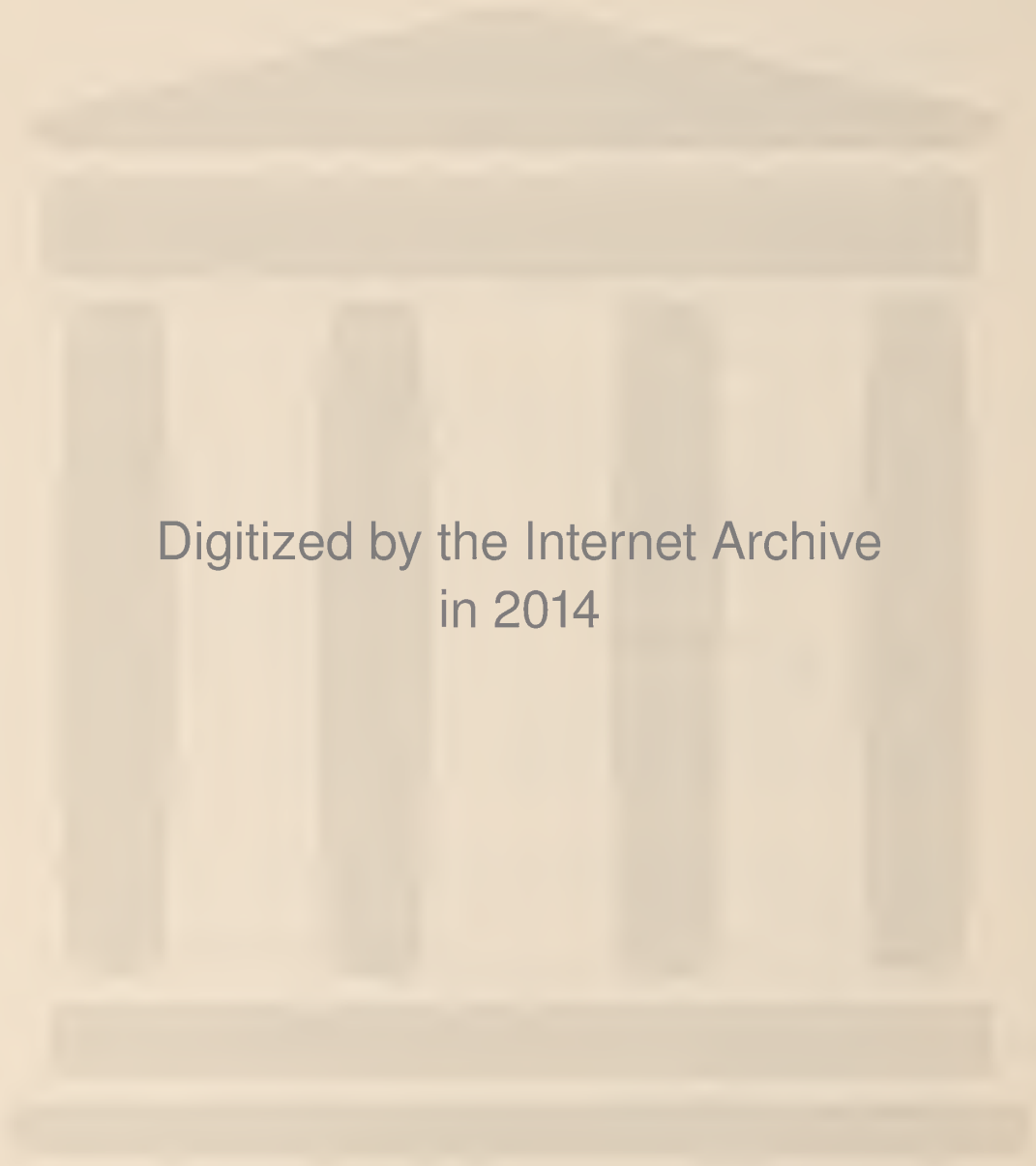
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SUMMARY

This paper presents predictions about the outcomes in 1980 of the Housing Allowance Supply Experiment in Green Bay (Brown County, Wisconsin) and South Bend (St. Joseph County, Indiana). The predictions are made using The Urban Institute's Housing Market Model, data about the two sites prior to 1975, and 1980 projections of population, income, and housing costs. Once made, the predictions are compared to the first two years of program results from the Supply Experiment.

The purpose of making the predictions and comparing their outcomes with the findings of the allowance experiments is to begin the process of validating and strengthening the Housing Market Model. The comparisons will provide information on model performance, which will help to improve not only its ability to project findings from the Supply Experiment to other metropolitan areas, but also its ability to predict the market effects of other housing programs (such as an expanded Section 8 program, rehabilitation programs for central cities) and market-related trends (such as rising construction costs).

The 1980 predictions of the model are consistent with the market effects predicted in previous simulations of housing allowance programs for the 1960-1970 decade. Considerably more than half the eligible population participates in the program and the average participant substantially increases his housing consumption. In Green Bay, where rapid population growth is predicted to have already forced the price of housing close to the price needed to elicit additional supply, the model finds

little price increase from the program. However, in South Bend, which is actually losing population and appears to have a decaying stock, the simulations find participants must pay sharply higher prices to obtain housing improvements.

By contrast, the Supply Experiment as of 1976 reports that the number of households receiving payments had leveled off at a third of the eligible population in Green Bay, and about a quarter in South Bend, though South Bend's participation was still rising. Furthermore, among those who were participating, the improvement in housing quality was modest. Most households remained in their pre-enrollment housing after making minor improvements, or none at all. Neither enrollments nor demands for housing improvement show signs of rising sharply in either site hence there is unlikely to be much pressure placed on the existing supply of housing by 1980. Because of this, there is little reason to expect any response in the price of housing services in Green Bay or South Bend, and as of 1976 none has yet been observed.

One implication from the comparisons is that the program participation and housing consumption responses of the model need strengthening. Both the Supply and Demand Experiments will provide unique information for this work. The experiments are making detailed analyses of households' participation decisions and will supply data that can be used to improve estimates of the behavioral parameters employed in the model.

The significant price effects predicted for South Bend by the housing model appear unlikely to occur, but this is because the experiment has generated only weak pressure for housing improvement. Further analysis of the experimental data is needed to reveal whether programs with higher

participation rates and stricter quality standards would create the pattern of price increases suggested by the model. Analysis of the data will also be important for improving the model's representation of landlords and homeowners, if that proves important in the experiment.

At present all implications from the comparisons must be considered tentative. The true strength of the model cannot be evaluated precisely until accurate input data for 1980 can be given the model, and until analysis of the experimental data is completed. However, the main points of the comparisons presented here are unlikely to change, and they indicate that benefits from improving the model with the findings of the allowance experiments will be considerable.

I. INTRODUCTION

The housing market research of the Integrated Analysis draws on the Urban Institute Housing Market Model and the Supply Experiment to develop an understanding of housing markets and the effects of large-scale housing programs.[1] Specifically, the Integrated Analysis seeks to improve the capacity for predicting the housing market effects of alternative housing programs in urban areas. Programs whose effects could be considered, in addition to housing allowances, include the Section 8 Housing Program, central city revitalization programs, and welfare reform. The process for improving this capacity is to evaluate and strengthen the model with the results of the Supply Experiment in Green Bay and South Bend.[2] Subsequently, the model can be applied to other urban areas for the 1970 or 1980 decade and used to simulate alternative programs for them.

Two earlier Integrated Analysis papers applied the model to Green Bay and South Bend.[3] The papers described the ability of the model to replicate the characteristics of both markets and reported estimates of key behavioral parameters used in the model. This paper begins an assessment of the model's ability to predict the market effects of housing allowance programs. Projections of housing allowance market effects for the 1970-1980 decade are presented and compared to results available to date from the Supply Experiment sites.

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[1] See Ozanne [8].

[2] Here and in the remainder of this paper, Green Bay refers to Brown County, Wisconsin, and South Bend to St. Joseph County, Indiana, unless otherwise stated.

[3] See Vanski [20] and Marshall [6].

To provide the reader with relevant background information, the remainder of this section presents a brief description of EHAP, the Supply Experiment and the development of the housing model.

The Experimental Housing Allowance Program

In 1970, Congress passed legislation that authorized the U.S. Department of Housing and Urban Development to establish EHAP to examine the feasibility of providing direct cash assistance to low-income families. Housing allowances in EHAP are designed to enable those families to obtain adequate housing at a reasonable cost. Unlike most other housing subsidy programs, payments in EHAP are made directly to participants, who can then choose their housing, as long as they occupy dwellings that meet program housing requirements.[1]

EHAP includes three experiments, each designed to fulfill a distinct research objective. The Administrative Agency Experiment was designed to provide information on various procedures for managing the program. The Demand Experiment addressed issues related to household behavior, such as participation and the extent to which participants use their allowance either as an income supplement or as a means of increasing their housing consumption. The Supply Experiment, the only experiment still in operation, investigates the effects of allowance payments on housing markets and prices.

A fourth design element of EHAP is the Integrated Analysis. The Integrated Analysis draws upon all sources of experimental data and analysis, links them appropriately to non-experimental data and provides an important

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[1] For a detailed discussion of the EHAP housing allowance concept and program design, see Carlson and Heinberg [2, Appendix A].

information source in determining how the housing allowance concept ties into the development of national housing policy.

The Supply Experiment

The Supply Experiment is being conducted in Green Bay, Wisconsin, and South Bend, Indiana. It is an open-enrollment program at these two sites--i.e., an allowance is provided to any household that meets program requirements. The Supply Experiment became operational in Green Bay in June 1974 and in South Bend in April 1975. The experiment will continue for five years; allowance payments will be made for an additional five years. This extended period (ten years in total) will encourage suppliers to make long-term investments and will enable a larger body of data to be compiled on the effects of allowance payments on housing markets and prices.

Because of budget constraints, the Supply Experiment was limited to two SMSAs (Standard Metropolitan Statistical Areas) with populations less than 250,000 and relatively isolated markets so that program effects could be more readily identified. Two small SMSAs are obviously not a statistical sample of housing markets that can be weighted to determine national response to housing allowances. The selection of Green Bay and South Bend, however, provides contrasts in rates of central-city growth and racial concentration--two factors considered critical by program designers in determining market effects. Green Bay is characterized as a rapid-growth area with a tight housing market and a small minority population. South Bend, in contrast, is losing population and has a relatively large percentage of minority households.

There are a number of other market characteristics of the two sites that should be taken into account when observing the market response to a housing allowance program. For example, both markets lack the large

concentrations of ghetto housing or highly concentrated ethnic communities that characterize larger cities such as New York, Chicago, or Miami. To the extent that housing market operations are influenced by the population that the market serves, neither Green Bay nor South Bend can be considered representative of large urban areas or small rural communities. Finally, both markets are heavily represented by homeownership and single-unit dwellings, which reduces the quality of information they can provide on the reaction of an extensive multi-unit rental market to an allowance program.

The Urban Institute Housing Model

During the course of EHAP, HUD has supported the development of computer simulation models to aid in extrapolating market effects beyond those reported in the Supply Experiment. One of these models is The Urban Institute Housing Model, under development since 1971, which was designed to obtain the effects of alternative public policies on the price and quantity of housing services. In addition to housing allowances, the model has been used to assess the impact of new construction subsidies, income redistribution programs, rehabilitation subsidies, and income tax incentives to homeownership.

This model operates at a relatively high level of aggregation; its simplified market representation permits calibration directly from census and FHA housing cost data. Thus, the model can be readily applied to a number of urban metropolitan areas. Another feature of the model is its decade time frame, which depicts ten-year changes in a housing market in terms of household location and the price and quantity of housing services

at the end of a specified decade. The model does not attempt to explain the adjustment process by which a market reaches its solution.

The theory underlying the model stresses two basic characteristics which distinguish housing from other goods and services: durability of existing structures and neighborhood effects. The supply and demand functions of the model, by accounting for these characteristics, depict the housing market as a number of closely related submarkets.[1]

The usefulness of the model in determining market response to housing allowances depends on how well it has incorporated those market characteristics which are most sensitive to policy intervention. Decision makers often use computer models in lieu of direct experimentation, in which case direct validation of model predictions is impossible. With the results from EHAP's Supply Experiment in Green Bay and South Bend, the Urban Institute Housing Model's predictions of the market effects of housing allowances can be directly compared with actual data. The quality of its predictions can thus be validated for two different types of housing markets, and its usefulness assessed for predicting market response elsewhere.

The Format of This Paper

The remainder of this paper is divided into four parts. Section II provides a comprehensive description of the model, including its inputs, solution procedure, and its stability in past applications. Section III describes the simulated market trends of Green Bay and South Bend for the 1970-1980 decade in the absence of EHAP. Section IV reports on the predicted changes in those trends caused by the existence of EHAP in the

[1] See de Leeuw and Struyk [4, Chapters 1 and 2].

two sites. The assessment of model performance and proposals for future model development are presented in Section V. An appendix provides specific details of the model inputs for the 1970-1980 projections.

II. MODEL STRUCTURE[1]

The Urban Institute Housing Model wad designed to analyze ten-year changes in the location of households and in the price and quantity of housing services within a metropolitan area. The urban area is generally delineated by five geographic zones, each designed to maximize homogeneity with respect to base-year housing quality, travel time to the area's central business district, and the socioeconomic mix of the residents. Typically, two zones will represent low- and high-quality central city neighborhoods; two will depict low- and high-quality suburban areas; and the last will contain all units newly constructed over a given decade. The primary exogenous inputs to the model are the 40 to 45 "model" households and "model" dwellings, which represent the population and housing stock, and a decade average for the operating and capital costs of newly constructed units. These describe the base-year supply of housing, and by describing the end-of-decade household composition and income distribution, they also determine housing demand. If the existing stock fails to meet demand through either depreciation or failure to account for population growth, builders enter to increase housing supply.

Assumptions

The model assumes that consumers of housing services seek to maximize utility, while suppliers maximize their profits. The structure of the

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[1]This section parallels the description of the housing model found in de Leeuw and Struyk [4] and Struyk, Marshall and Ozanne [15]. For those already familiar with the model, this section can easily be omitted.

model also depends on four other basic assumptions. First, the continuous functions used to describe supply and demand behavior rely heavily on the assumption that landlords and households behave in a consistent and rational manner. Second, the model assumes that the consumption decision of households is independent of the production decision of landlords, and thus does not have to differentiate between renters and owner-occupants. The third assumption is that the housing market is competitive and services are allocated among competing consumers by a price mechanism. The fourth assumption maintains that this price mechanism does not dictate a single market price for services and that submarkets can exist in equilibrium because dwelling units are not perfect substitutes, either in terms of supply or demand.

Basic Components: Four Actors

The model accounts for the behavior of four separate actors: households that consume housing services; landlords who control the existing rental housing stock; builders who construct new units; and the government, which can exert influence on the market through various programs and regulations. The following paragraphs describe how these sectors are accounted for in the model.

Households. Each of the 40 or so model households represents several hundred or thousand actual households at the end of the decade. The households are usually divided into four categories, recognizing both the differences in the amount of income that certain types of households are willing to spend on housing and the effect of racial segregation on market operations. The four household categories are: (1) white non-elderly

families (with household head less than 65 years of age), (2) white elderly and single-person households, (3) black non-elderly families, and (4) black elderly and single-person households.

Each model household is characterized by two income figures. The first, actual income, is used in determining eligibility for government programs and the size of allowance payments. The second income measure is an approximation of the household's permanent income and is considered the more relevant one in determining levels of housing consumption.

The behavior of a household is defined by its utility function. Given its permanent income, a household cannot consume less than a certain minimum level of housing services, determined by the amount it is willing to spend on housing, the price of new construction and the price elasticity of demand. At the same time, the household must live within its budget by not spending more than its income on housing and other goods and services. Thus, a household's decision to occupy a particular dwelling--new or existing--depends on its income, the price and quantity of services offered by that dwelling unit, and the price and quantity of services offered by other dwellings.

A final consideration of the household is the location of the dwelling. The household utility function takes into account three characteristics of the zone in which the dwelling is located: (1) the monthly travel time to and from place of employment; (2) the proportion of households in the zone that are of the same race; and (3) the average net rent of households residing in the zone, a proxy for zonal affluence. Travel time is treated as an exogenous input to the model. Racial concentration and average net rent are computed endogenously, and change as households alter their housing choices.

Two sets of model parameters are used in the utility function defining household behavior. The first set is the α_i, in which the subscript "i" refers to the household types mentioned previously. The α_i expresses the strength of household preferences for housing versus other goods and services; α_i can be considered a rough approximation of housing expenditure-to-income ratios.

A second set of parameters describes more subtle aspects of behavior in the housing market. The first parameter in the set, γ_1, is a measure of the degree to which households substitute among the various housing bundles available to them with respect to price differentials. Two other γ parameters reflect household response to zone characteristics: γ_2 measures the strength of household preference for residing in a zone with high net rent; γ_3, the strength of household preference for a zone with a high proportion of other households of the same race.

Landlords. The dwelling units offered by landlords in the four zones are characterized by the quantity of services provided at the beginning of the decade being simulated. The quantity of services offered by a dwelling unit is one of the key concepts of the model. It refers specifically to a composite index of all services, determined by the physical structure of a dwelling--size, plumbing, design, privacy, etc. Not included in this index are neighborhood attributes; these are accounted for by the three zone characteristics mentioned above.

The landlords of existing dwellings offer their units at the price-quantity combination that maximizes expected profits. These combinations lie along a supply schedule. The position of the schedule depends on the initial quantity of services offered by the dwelling and on the model's two supply parameters, one of which is related to the depreciation rate;

the other, to the responsiveness of supply to a change in price. Because expected profits are increasing functions of the landlord's position on the supply curve, the owner attempts to move as high on the curve as possible without causing the unit to be vacated. Dwellings are withdrawn from the housing stock when an occupant cannot be found at a price at least equal to the operating cost. In the real world, such a withdrawal can represent a long-term vacancy, demolition, conversion to non-residential use, or abandonment.

Builders. The housing model characterizes builders by a perfectly elastic supply curve. The position of that curve, which gives the price per unit of service for new dwellings, is determined separately for each housing market and supplied exogenously to the model.

The price per unit of service is actually an average of a housing price index computed over the decade being simulated. The index is calculated relative to the cost of existing dwellings during the simulation's base year and is a composite of operating and capital costs. The new construction price tends to set a ceiling for the price structure of the existing stock especially for dwelling units in the moderate- to high-quality range. It is possible, however, for dwellings with favorable zone characteristics to command a price higher than that specified for new units; higher prices can also occur when government regulations artificially increase demand in certain sectors of the housing market.

Government. The government can influence the housing market in a number of ways. Specifically, the model is designed to analyze the effects of tax changes, allowance payments, transfer payments with or without

earmarking for housing,[1] minimum new construction requirements, and minimum quantity requirements for housing services in a particular zone.

In replicating a housing allowance program, the model first calculates allowance payments for eligible households and adds an adjusted amount to their permanent income. Because the policy being simulated is designed to earmark the allowance to induce increased housing consumption, the model then requires eligible households to consume some minimum quantity of service or spend some minimum amount on rent to qualify for the allowance. The household ultimately compares its utility-maximizing choice without the allowance to its optimal choice with the allowance (including minimum requirements) and chooses the larger of the two.

The Solution Process

A solution is attained when none of the four actors of the model has an incentive to change. Each household is the sole occupant of the dwelling unit that produces services at a price-quantity combination maximizing its utility. The model assumes that each landlord of an existing dwelling unit receives the highest price for the unit without causing it to be vacant, and is thus maximizing profit. The building industry provides new units whenever households want to purchase them. And the government regulations are strictly enforced.

The computer program used to solve the model searches for a solution using a trial-and-error process. Departures from the solution conditions in one trial govern the way in which the solution is modified in the next.

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[1] Earmarking is an incentive built into a housing program that forces families to spend more of their income on housing than they would ordinarily.

Model Limitations

No description of a computer simulation model would be complete without a description of its limitations. The limitations of the housing model have been documented elsewhere so we will only mention them briefly. The Urban Institute Housing Model cannot capture any of the short-run dynamics of housing markets; it is only capable of describing ten-year changes in housing conditions. The model does not take account of land markets or markets for other inputs to housing services such as construction materials, labor, and financing. The model also fails to take account of feedbacks from the prices and quantities of housing services rendered in a market, and thus fixes income distributions regardless of landlord-owner profits or rent levels.

Beyond these general model limitations, one specific weakness of the housing model in its current form pertains to the parameters that determine the behavior of landlords who supply housing services. The model can identify only a range of supply parameters which, in turn, define a wide range of supply elasticities. Uncertainty of the true values of supply parameters requires simulation of a range of market responses to policy innovations.

The final point to make concerning model limitations is the level of aggregation used in the housing model. Although it may accurately depict overall market response to housing allowances, representation of an entire housing market by 40 to 45 model dwelling units and households necessarily precludes taking account of many detailed aspects of market operations and policies. This limitation relates both to the simplified procedures used to implement program rules for standards and eligibility

within the model[1] and to difficulties encountered when trying to depict household behavior in the consumption of housing services. The inability of the model to differentiate behavior with respect to tenure, smaller geographic areas, or more household categories are important examples of this problem.

However, despite these limitations, the model has performed well in its applications over the 1960s in terms of the stability of its parameters which describe the behavior of consumers of housing services and the consistency it has demonstrated under variation of these parameters.[2] The model has been calibrated to eight metropolitan areas over the 1960-70 decade: Austin, Texas; Chicago, Illinois; Durham, North Carolina; Green Bay, Wisconsin; Pittsburgh, Pennsylvania; Portland, Oregon; South Bend, Indiana; and Washington, D.C. The systematic representation of market response in areas that demonstrate such a wide variety of market conditions contributes to the reliability of the model. Although there have been no real data against which to check the result of policy simulations, the predictability and consistency of market response to a variety of housing policies have led to some confidence in the model's usefulness as a tool for policy analysis. The following three sections of the paper provide the first attempt at validating the model's predictions of market response to housing policy.

---

[1] The procedures used to implement program rules are described in detail in Section IV.

[2] See de Leeuw and Struyk [4, Chapters V and VI].

III. 1970-1980 HOUSING MARKET TRENDS IN GREEN BAY AND SOUTH BEND

To project the market effects of housing allowances in 1980 for Green Bay and South Bend, the model requires a variety of inputs. As identified in the previous section, these inputs are: (1) parameter values for household utility and landlord supply functions, (2) an index of services provided by the existing stock in 1970, (3) the price of new construction over the decade, (4) the number of households in 1980 identified by their income and family composition (and in South Bend, by their race), (5) program characteristics determining eligibility and size of the allowances.

Projection of the market effects of housing allowances in 1980 also requires projection of the housing market situation in the absence of such a program. The net effect of the allowance program is isolated by comparing the markets generated by both simulations.[1] Following a description of the first four inputs listed above, this section presents the no-policy simulations of the Green Bay and South Bend housing markets for 1980. These simulations are used to determine whether the model can portray the basic trends over the 1970-1980 decade in each market. Specification of the allowance program characteristics and comparison of allowance simulations with the simulations of basic trends are presented in Section IV.

Behavioral Parameter Inputs

Part of the exogenous input to the model consists of the utility and supply function parameters that define the behavior of consumers and

[1] Throughout the paper, the simulation of the market without a housing allowance program is referred to as a no-policy simulation.

producers of housing services over the decade. The three sets of parameters used for the 1970-1980 decade simulations are the same as those estimated for Green Bay and South Bend in the 1960-1970 calibrations of the model.[1] Reestimation of the two supply parameters was not possible because of the lack of detailed data for 1980. The utility parameters describing price responsiveness (γ_1), household preferences for zones (γ_2) and their preferences for race (γ_3) were reestimated for 1970. However, they showed little change and were left at their 1960 values to maintain consistency with the supply parameters.

The utility function parameters that correspond to the fraction of income spent on housing (α_i) were not reestimated for 1980, despite data from the Supply Experiment that suggested increases for certain household types in 1974. The reported rise in housing-expense-to-income ratios for 1974 was felt to reflect the sudden change in the relationship between real income and housing prices caused by that year's recession and rapid inflation in housing costs. It is impossible to determine whether these changes would be long enough lasting to alter consumer behavior in 1980. There are other studies that document the increase in housing expenditure faced by households in the early 1970s, but there are also studies that suggest that households gradually reduce the quality of units they purchase when prices rise.[2] The process of reducing quality may mitigate the effect on expenditures of sharp increase in the cost of housing over the long-run. Given the conflicting evidence and the stability of these parameters from 1950

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[1] See Marshall [6, pp. 31-34] and Vanski [20, pp. 32-33].

[2] Evidence of short-run increases in housing-expense-to-income ratios can be found in Sternlieb, Burchell and Listokin [11]. Some evidence of the long-run adjustment of quality to price increases can be found in de Leeuw, Schnare and Struyk, [3].

to 1970, 1970 values were chosen to indicate the underlying behavioral relationship at the end of the decade.

Besides the behavioral parameters, inputs to the model include the initial stock of housing, end-of-decade population characteristics, and the index of new construction costs for the decade. The former is derived from 1970 Census data for both sites using normal model procedures. The latter two inputs require projections to 1980 of household composition and income, as well as projections to 1980 of the capital and operating costs for housing.[1] Results of these projections are reported separately for Green Bay and South Bend, along with the results of our simulations of 1980 market conditions.

Green Bay, 1970-1980[2]

The Green Bay SMSA was chosen as a site for the Supply Experiment because of its rapid economic growth and low concentration of racial minorities. According to the projections used for 1970-1980 simulations, the growth in household population will be reduced from the 26-percent rate of growth experienced during the decade of the 1960s to 12 percent. The minority population is expected to remain less than 2 percent of the total. Households in Green Bay are divided into two categories: (1) non-elderly families with heads under 65, and (2) elderly families and single-person households. Unlike national trends, which show a decline in the proportion of non-elderly families, the projections for

[1] A more detailed discussion of all 1970-1980 inputs is provided in the Appendix.

[2] A comprehensive description of current supply site market characteristics can be found in The Rand Corporation [19].

Green Bay show an increase of 19 percent for the non-elderly and a decline of 7 percent for the elderly and single. The large increase in non-elderly households probably is due to the large amount of migration into the SMSA resulting from its vigorous economic growth.

National projections of nominal income for the 1970s show a decade increase of close to 100 percent. Income estimates for Green Bay, however, show an 88-percent increase. The median income of elderly and single-person households is projected to increase in Green Bay by 99 percent, as opposed to an 82-percent increase for the non-elderly. It should be remembered that the gains in real income over the 1970s are significantly less than those in nominal incomes and are below the real gains during the 1960s.

Besides the household population and income distributions, exogenous information used by the model includes projections on the price of newly constructed housing. In Green Bay that price, a composite of capital and operating costs, is projected to increase by 105 percent over the decade. Capital costs increase by 97 percent; operating costs, by 115 percent. The larger gain in operating costs is attributable mainly to dramatic increases in utility costs.[1] The rapid increases contrast with experience over the 1960s when the new construction price in Green Bay rose 34 percent, reflecting a 42-percent increase in capital costs and 23-percent increase in operating costs.[2]

Using the above inputs, the model can simulate what the 1970-1980 market trends in Green Bay would be in the absence of an allowance program.

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[1] See "Factor Input Prices" in the Appendix.

[2] Based on price index calculations for the 1960-1970 decade simulations for Green Bay. See Vanski [20].

These are the no-policy simulations referred to previously. The simulations show a 135-percent increase in housing expenditure over the decade, only 6 percent of which is due to increased housing consumption. The remainder is attributable to increased prices for housing. Over the 1960-1970 decade, expenditures rose only 69 percent, and 45 percentage points of this increase represented increased housing consumption.[1]

The rapid rise in price that discourages consumption increases in the 1970-1980 simulations also leads to greater use of the existing stock. In the 1960s when income growth outpaced price increases, the smallest dwellings were withdrawn from use, while larger new dwellings were built. In the 1970s withdrawals essentially stop and the only new construction in the simulations is to accommodate the increased population. New construction is still substantial, amounting to 13 percent of the 1980 stock of dwellings.

A device commonly used to summarize the results of the housing model simulations is the price-structure curve. Figure 1 illustrates the 1980 price-structure curves for Green Bay under both inelastic and elastic supply assumptions.[2] The horizontal axis in the figure represents the quantity of housing services produced by each dwelling; the vertical axis measures the price per unit of housing service. The points on the two curves represent specific model dwellings and can be considered as the intersections of negatively sloped demand curves with positively sloped supply curves.

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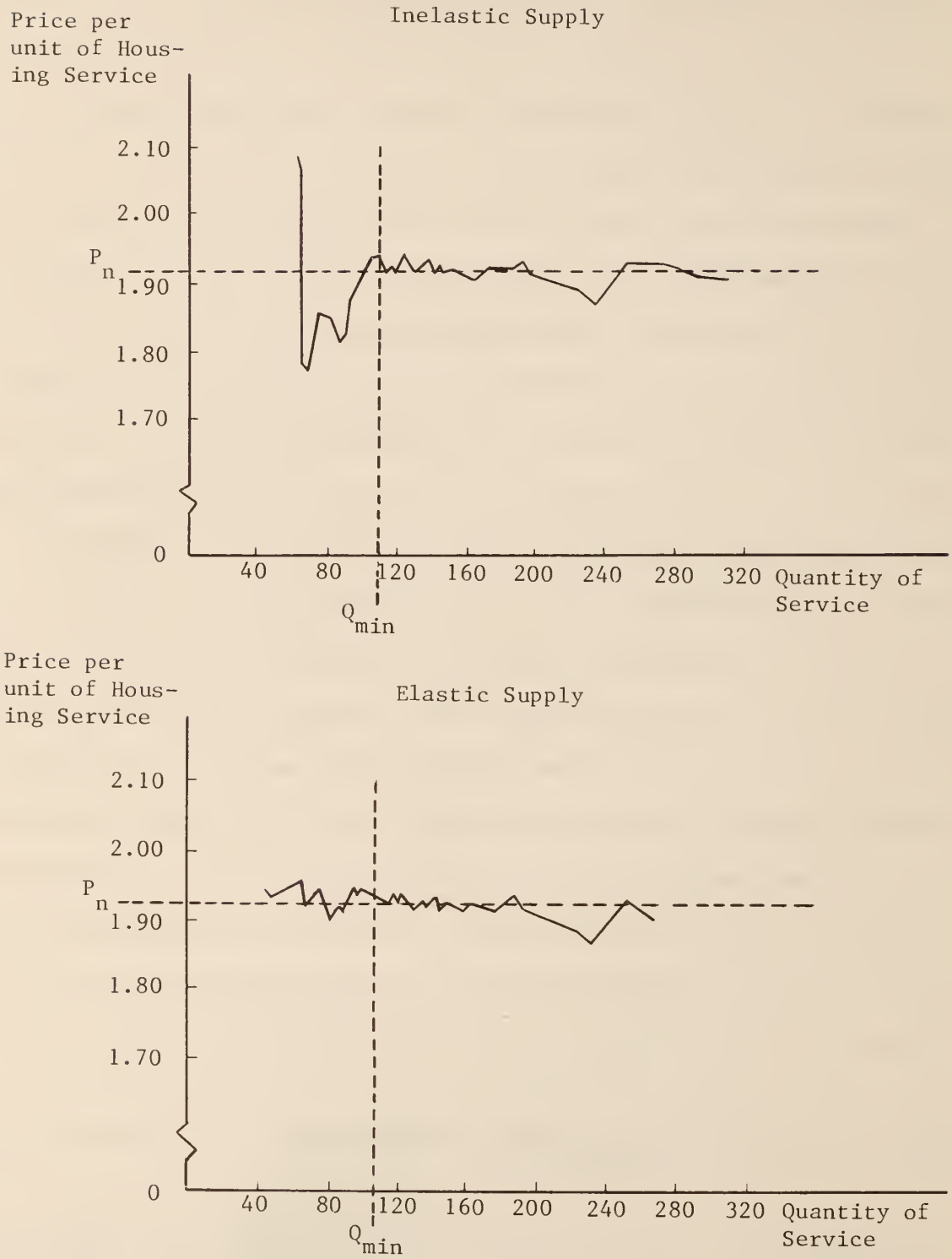
[1]The 1960 to 1970 figures are taken from the 1960-1970 calibration of the model to Green Bay. See Vanski [20].

[2]The supply function parameters are imprecisely known, as mentioned in Section II. Consequently, a range of supply elasticities is used for the existing housing stock. Runs are made under both elastic and inelastic supply assumptions to define the range in which actual market response is expected to lie.

Figure 1. Price-Structure Curves: Green Bay, Winconsin, 1980



The price, P_n, depicted in the figure is an index for the price of new units. P_n tends to serve as a ceiling for the price of dwellings in the moderate- to high-quality range because households would be very unlikely to pay more for an existing dwelling than for a new unit offering identical services. Exceptions to the ceiling concept, however, occur when neighborhood effects increase the demand for a specific dwelling or when zoning regulations bar new construction from an area of the market. The price, P_o, shown in the graph represents the operating costs of maintaining a dwelling. If the price for a dwelling falls below this level, the dwelling would be withdrawn from the stock of available units.

Under both sets of supply parameters, the demand for housing is sufficiently large to keep the price of housing close to the new construction price in the quality range above Q_{min}, the minimum acceptable quality level estimated to be consistent with local zoning and building code requirements. Below Q_{min}, however, the price structure varies. The demand for housing in the low-quality sector is dependent on three factors: (1) growth in real income, (2) depreciation of the housing stock, and (3) population growth among low-income households. The first two factors tend to create an excess supply of low-quality units, while the third decreases supply. In 1980, all three forces seem to be almost balanced in Green Bay. However, inelastic supply parameters lead to a slight discount in the price of some low-quality units.[1]

South Bend, 1970-1980

The choice of South Bend as a site for EHAP's Supply Experiment rested on its slow growth and significant black population. A decline in the

[1]The two lowest-quality units show a substantial price premium. Although this may be interpreted as a result of sparse housing supply for the market's poorest households, it might well be caused by the high level of aggregation used in the model.

area's manufacturing industry led to slow population growth during the period 1960-1970, and a population loss of 9 percent in the early 1970s. National data on household composition suggest a trend toward smaller and single-person households. Assuming that South Bend parallels national trends, projections for its household population to 1980 were tempered; the loss over the decade was limited to a 2-percent reduction in the number of the area's households.

In 1975, close to 10 percent of South Bend's households were black. According to the Census, their number increased by 30 percent during the 1960s, and nearly doubled from 1960 to 1975. The presence of a substantial minority population permitted a division of model households into four types: (1) white non-elderly families, (2) white elderly families and single-person households, (3) black non-elderly families, and (4) black elderly and single households. The projections for the 1970 decade assume a 60-percent growth in the number of minority households. Within each race, estimates for South Bend, like those for the nation, show the relative gain in the number of elderly and single-person households.

The projected increase in new housing prices for South Bend during the 1970s is 96 percent. The components of this price increase are projected to be a 125-percent increase in operating costs and a 75-percent increase in capital prices. As in Green Bay, estimated price increases in South Bend have risen dramatically in the 1970s. The same price index over the 1960s increased 39 percent, reflecting a 42-percent increase in capital costs and a 35-percent increase in operating costs.

The inputs for South Bend, when used in the no-policy simulations, show a much larger increase in housing expenditures over the 1970s than

the 1960s, as did the Green Bay simulations. The increase in South Bend is 78 percent for the 1970s, compared to 25 percent for the 1960s.[1] Like Green Bay, the 1970 increase largely stems from price increases. Housing consumption is projected to increase 5 percent in the 1970s; the 1960s' counterpart is 42 percent. Unlike Green Bay, there is a continuing withdrawal of existing dwellings because of the population decline and, in the elastic case, a small amount of new construction. This looseness in the market keeps average prices from rising as rapidly as in the Green Bay simulations and helps explain why expenditure increases in the South Bend simulations are less than two-thirds of the level in Green Bay.[2]

Figure 2 presents the two 1980 price-structure curves for South Bend. Under the assumption of an inelastic supply of housing, there is no new construction in the market, and the market price per unit of service is discounted over the entire range of housing services. The discounting is most pronounced in the sector containing lower-quality units, however.[3] The elastic price-structure curve depicts the existing stock as more competitive with new construction, although the price-discounting phenomenon is still pronounced in the low-quality range. Under the assumption of elastic supply, 5 percent of the 1980 stock will have been built during the decade. This new construction is of higher quality and houses the

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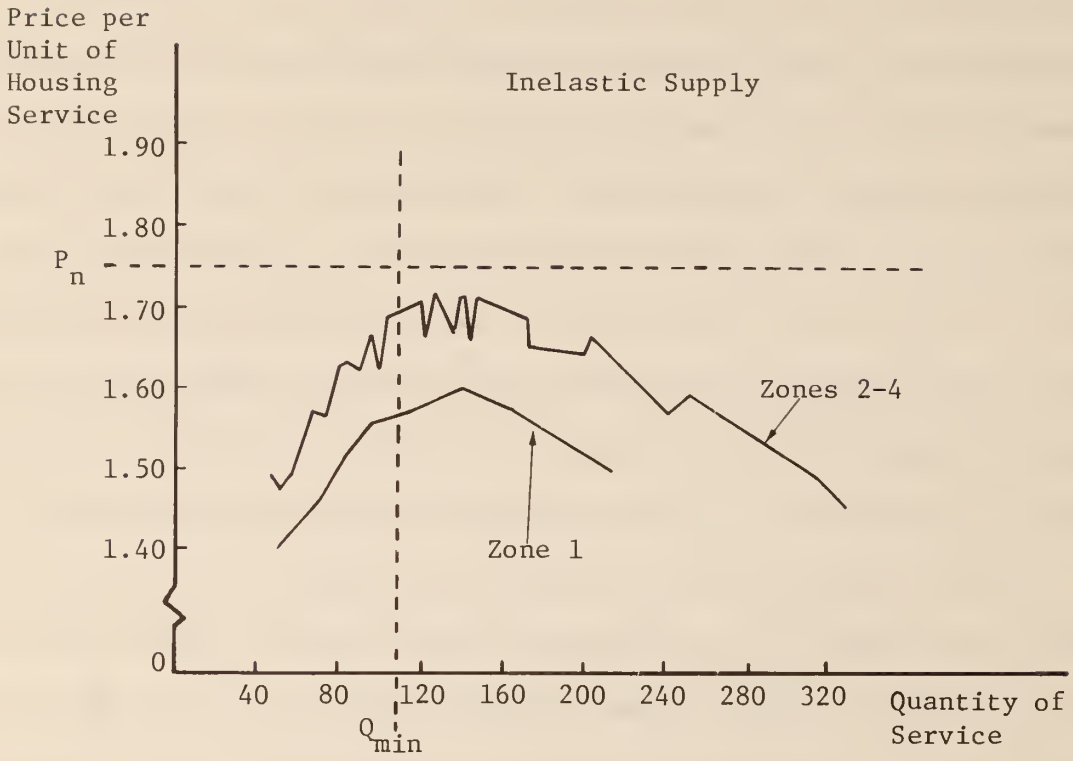
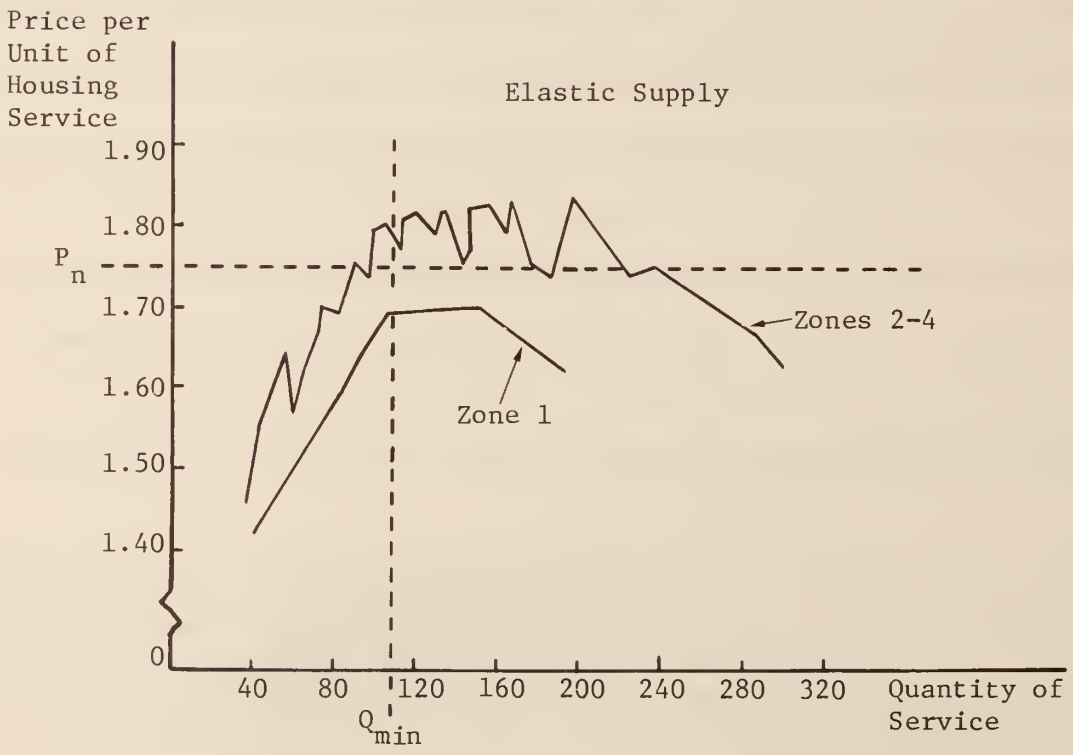
[1]The 1960 percentages are derived from the calibration to South Bend reported in Marshall [6].

[2]These price increases are for existing and new dwelling units. For new units, the price increase is exogenously set at 96 percent as cited above, but the price of existing units fluctuates with market demand. The weak demand in South Bend fails to raise prices for existing units by as much as they go up in Green Bay. See the price-structure curve of Figure 2 and the related discussion.

[3]The higher-quality dwellings also appear to be discounted. This probably results from the aggregation in the model.

Fig. 2. Price-Structure Curves: South Bend, Indiana, 1980





wealthier households in the market.

South Bend's price-structure diagrams each show a separate curve for Zone 1. Much of South Bend's minority population is concentrated in this zone; the housing is severely discounted due to its neighborhood characteristics; and new construction is not a viable alternative to supplement the existing stock at any level of service. For all practical purposes, there is a dual housing market in the SMSA. Of the remaining zones, Zones 2 and 4--the wealthier central city and suburban zones--show the greatest increases in quality and the greatest ability to attract more affluent households. Even so, the 1980 housing stock in these zones shows little improvement over 1970. Thus, by 1980, the quality of South Bend's housing stock is either holding constant or moderately deteriorating; this process is consistent with the 1960s and shows little sign of improvement.

Summary of 1970-1980 No-Policy Projections

The 1970-1980 simulations for Green Bay and South Bend represent some of the first attempts at running the model beyond the historical period during which it was developed. There was some question initially about how well the model would perform during the 1970s because it was the first time that the model had been run when increases in housing expenditures were outstripping increases in income; and, in the case of South Bend, the model first encountered a metropolitan area that experienced a decline in population. The model, however, is still able to describe reasonable trends for both housing markets. Table 1 provides a summary of the decade trends discussed in this section.

Table 1

COMPARISON OF MARKET CHARACTERISTICS OF GREEN BAY AND SOUTH BEND, 1960s and 1970s

Items	Green Bay, Wisconsin		South Bend, Indiana	
	1960 - 1970	1970 - 1980	1960-1970	1970-1980
Projections of Exogenous Input:				
Percent increase in household population:				
Non-elderly families	25	19	-3	-6
Elderly or single-person households	46	-7	59	7
Minority households	--	--	42	60
Total	29	12	10	-2
Percent increase in nominal income per household	63	88	40	75
Increase in the price of new housing:				
Operating costs	23	115	35	125
Capital costs	42	97	42	75
Total	34	105	39	96
Endogenous Projections:				
Percent increase in housing expenditures	69	135	25	78
Percent increase in housing quantity	45	6	42	5
Withdrawals as a percent of beginning-of-decade stock	7	0	14	6
New construction as a percent of end-of-decade stock	29	13	20	3

NOTE: Where there is a range of response due to differing elasticities, an average is shown. In all cases, the range represented by the average is narrow.

IV. 1970-1980 HOUSING ALLOWANCE SIMULATIONS FOR GREEN BAY AND SOUTH BEND

This section describes how housing allowances are characterized in the model and then presents a set of allowance program simulations for Green Bay and South Bend. The simulations illustrate the broad range of detailed predictions that can be produced by the model. Differences between the sites are outlined and predictions for the sites are compared to previous simulations of the model.

Representing Housing Allowances in the Model

Housing allowances are represented in the model by parameter inputs, which attempt to capture the main features of a housing allowance program. The parameter inputs determine eligibility, allowance payments and housing standards. The behavioral responses of households to these inputs generate the program's impact on the market.

The number of households in the model that are eligible for housing allowances is obtained from an estimate of the eligible population in each site.[1] This estimate is used to designate each household in the model eligible or ineligible on the basis of its income and family characteristics.

Potential allowances for these households are determined in the model

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[1]An eligible household is defined in this paper as a household that meets program requirements for income, assets and family composition, but need not meet program housing standards. Eligibility estimates for the experimental sites are discussed later in this section.

by the housing gap formula,

$$P = C^* - bY, \quad \text{for } Y < C^*/b, \text{ and}$$

$$P = 0 \quad \text{for all other cases,}$$

where P = allowance payment,

C^* = estimate of market rent for adequate housing,

b = the rate at which the allowance is reduced as income increases (sometimes called a household's contribution rate), and

Y = program-defined income.

Household income in the model is census-reported total income, whereas that used in EHAP is adjusted gross income. Because the latter figure is derived after several deductions from total income, the b value in the model is reduced from EHAP's value of .25 to .20.[1]

The values of C* are constrained so that model households specified as eligible receive an allowance, and others receive none. Within this constraint, the C* values are based on projections to 1980 of the Supply Experiment's estimated cost of standard housing. Because the cost of standard housing differs by size of household in the experiment, the model has separate C* values for non-elderly households and elderly households. Non-elderly, single-person households are categorically ineligible and hence have no C* values.[2]

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[1]The b value of .20 applied to total income produces similar allowances as the b value of .25 applied to total income less typical exclusions for incomes in the range of likely allowance recipients. The appropriateness of the ratio has not been tested with experience in Green Bay or South Bend, nor has there been a test comparing incomes reported on surveys with those verified by the program.

[2]Single-person families with head of household between 18 and 62 years of age became eligible to receive allowance payments as of January 1, 1977, but remain ineligible in these simulations.

Standard housing, which eligible households must occupy to receive an allowance, is represented in the model as a minimum quantity of housing services.[1] The minimum quantity is determined by dividing the estimated market rent for standard housing, C*, by the exogenously determined new construction price for a unit of service. There is no direct link between this amount and the housing quality standards of the experiment. Those standards consist of a list of required dwelling unit attributes. They conceptually could be translated into an index of services, but that has not been done in the experiment, and the data required for doing so are rarely available elsewhere. It should be noted that there is no necessary relationship between the level of services a dwelling unit provides in the model and whether or not it possesses all the attributes required by the standards set in the Supply Experiment. For example, a luxury one-bedroom apartment can register high on an index of services provided and rent for much more than C*, but still lack the amount of space required by EHAP program standards for a three-person family.

The behavioral response of a household to the allowance program is represented in the model by a shift in the demand for standard dwellings. During the model's search for a solution, a household chooses the dwelling unit that yields the greatest benefits consistent with its income, the price of each other dwelling and the price of other goods and services. When the household is eligible for an allowance, the allowance payment is automatically added to its income every time the household considers a dwelling unit that provides more than the minimum standard of services. The increased income raises the household's demand for dwellings that are above standard.

[1] See Section II for a description of how the model measures all aspects of housing quality and quantity as a one-dimensional flow of housing services.

In spite of a household's increased demand for above-standard dwellings, it could still receive greater benefit from a substandard one. For example, other eligible households in the model could bid the price of better quality units up so high that the lower cost of substandard dwellings makes them more attractive to poorer households. When a household eligible for an allowance occupies a substandard dwelling, that family is classified as a non-participant.

Thus, the participation decision in the model is solely one of weighing the advantages of occupying a larger but more expensive dwelling unit and receiving an allowance, against the decision to occupy a smaller but less expensive one without an allowance. There is no separate decision to enroll.

The increase in a household's demand caused by the allowance program depends to a large extent on the size of the household's allowance payment. In the model, the current value of the allowance, calculated by the housing-gap formula, is converted by the household to an expected permanent level of subsidy before it is added to the household's income. The conversion process is derived from aggregate U.S. data on household income and housing consumption in 1970. The process has not been tested against individual households' treatment of transfer payments.[1]

This representation of a housing allowance program has been used extensively in the model to predict the effect of housing allowances for the 1960s. The model has produced consistent results across the metropolitan areas to which it has been applied.[2] There has never been an occasion,

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[1]For a discussion of this conversion procedure see L. Ozanne [7]. Model households designated ineligible are assessed a small tax to cover the cost of the allowances. The tax, like the allowance, is determined from current income but has its effect through changes in permanent income.

[2]See Ozanne [9].

however, to compare predictions from housing allowance simulations to data from an actual allowance program--that is the task begun by this paper. There is considerably more uncertainty about how well the model predicts the effects of an allowance program than there is about the model's prediction of basic market trends.

The remainder of this section reports the predictions of allowance program effects for each of the Supply sites.

Market Effects in Green Bay

About 18.5 percent of the households in the model were designated eligible to receive allowances in Green Bay, the same rate as that reported by the Supply Experiment for Green Bay in 1974. The cost of minimum standard housing, C*, was set at $197 per month for the non-elderly and $158 for the elderly or single-person households. These projected values represent a 12-percent increase in cost over the next four years when compared with actual January 1976 values in the Supply Experiment of $175 per month for the non-elderly and $140 for the elderly.[1] The implied income eligibility limits are $11,820 for the former and $9,480 for the latter. The model imposes quality standards by translating the standard cost data into minimum levels of service which must be purchased by households participating in the program. These service levels are 103 units for the non-elderly, and 82 units for the elderly.

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[1]The comparable site data are derived from Rand's Third Annual Report [19, Table 2.2]. In January 1976, the C* for non-elderly households assumed an average of four persons per household; the C* for elderly households assumed two persons. In the 2.5 years of data reported by Rand, the standard cost of housing for the former group showed a 13-percent rise, while that for the latter increased 16 percent. These increases reflect both standard adjustments for smaller households and rising utility costs, suggesting that the cost increases might level off toward the end of the decade.

As can be seen from Table 2, the model's eligible population for 1980 is composed of seven households--four non-elderly and three elderly. On the average, the non-elderly have an annual 1980 gross income of $6,899, making them eligible for a monthly allowance of $82; the elderly earn about $5,199 per year and are eligible for an allowance of $71 per month.

Table 3 summarizes the results of the housing allowance simulations for Green Bay. As mentioned previously, simulations are run under both elastic and inelastic supply assumptions in an attempt to capture the range of actual program impacts.

In Green Bay, program participation under both sets of parameters is 57 percent of the eligible population--half of those participating are non-elderly families; half are the elderly families. Those who decide to participate are generally the wealthier eligible households, as reflected by the low allowance payments received--$55 per month under inelastic supply assumptions, and $45 under the elastic.

The remaining entries in Table 3 show the net effects of the allowance program on the Green Bay market in 1980. These are obtained by comparing the allowance simulations and the no-policy simulations from Section III.

The earmarking ratios reported for participating households suggest that the allowance program channels between 83 and 97 cents of each allowance dollar into increased housing expenditures. The high earmarking ratios generated by the model reflect the large gap between the housing consumption of eligible households in the no-policy simulations and the housing standards required under the policy runs. Of the households that participate, the model estimates that only 25 percent would have met the allowance standards if the housing allowance program were not in effect.

Table 2

CHARACTERISTICS OF THE ELIGIBLE POPULATION IN GREEN BAY, 1980

Type of Household	C* ($ per Month)	Annual Gross Income Limit	Minimum Quantity of Housing Services	Model Household Population			
				Number of Model Households	Percent of Eligible Population	Annual Gross Income	Monthly Subsidy
Non-elderly	$197	$11,820	103	4	57	$6,899	$82
Elderly	$158	$ 9,480	82	3	43	$5,199	$71

Table 3

SIMULATION RESULTS FOR GREEN BAY, 1980

Measures	Supply Elasticity[a]	
	Inelastic	Elastic
Participation rate, percent	57	57
Average allowance per month, $	55	45
Earmarking ratios for participating households[b]	.97	.83
Expenditures	38	23
Quantity	27	18
Price	9	4
Expenditure change due to change in price	24	17
Eligible non-participating households		
Expenditures	-33	-23
Quantity	-14	- 8
Price	-22	-16
Expenditure change due to change in price	67	70
Near-eligible households[c]		
Expenditures	2	0
Quantity	0	0
Price	2	0
Expenditure change due to change in price	100	0
All households		
Expenditures	1	0
Quantity	1	1
Price	0	0
Expenditure change due to change in price	0	NA
Additional withdrawals from the no-policy simulations	3	3

[a]Entries show percent increase for expenditures, quantity, price and withdrawals.

[b]The earmarking ratio is average expenditure change divided by average subsidy.

[c]Near-eligible households have incomes between the income limit for the program and 1.5 times that limit. Also included are non-elderly single persons with incomes below program limits.

NA indicates not applicable.

The data in Table 3 also illustrate that the major impact of the simulated allowance program falls on the eligible population, those households to which the program is targeted. The impact of the program, however, is markedly different for those electing to participate than for those who decide to forego the allowance.

As the high earmarking ratio suggests, households that choose to participate in the allowance program are induced to increase their housing expenditures over what they would have been in the program's absence. This expenditure increase ranges from 23 to 38 percent. The demand stimulus also has an impact on prices. But the impact--caused by the program, not by the underlying inflationary trend--is relatively minor. The inflationary impact on participants is estimated to be between 4 and 9 percent. This means that most of the induced increase in spending is directly attributable to an increase in housing quantity. This increase ranges from 18 to 27 percent.

There is an additional indirect benefit to the second group in the table--those who are eligible, but do not participate in the program. These are the households who take advantage of the decrease in demand for units below program housing standards. Households not participating experience decreases in expenditures almost comparable in magnitude to the increases of families receiving allowances (23 to 33 percent). In the case of these households, more than two-thirds of this reduction is directly attributable to a decline in the price of housing services. The effects on quantity therefore are minimized and there is only an 8- to 14-percent reduction in quantity consumed.

The third group of households described in Table 3 are the near-eligibles. This group includes both households just beyond income eligibility and

non-elderly single-person households that are prohibited from receiving allowances according to program regulations. It is believed by some that the demand stimulus generated by an allowance program would cause participants to compete directly with this group for housing services. The results for the Green Bay projections show no allowance-induced impact on the near-eligibles. The only non-zero table entry shows a 2-percent increase in expenditures, which is entirely attributable to price pressures in an inelastic market.

As noted earlier, the simulated allowance program has practically no market effects overall. The increase in expenditures caused by the program ranges between 0 and 1 percent for the market as a whole. There is an estimated 1-percent increase in housing quality and no increase in price.

Besides price and quantity impacts, the model also provides information on program-induced withdrawals from the existing stock, new construction and changes in locational choice. For Green Bay, the simulated allowances cause about 3 percent of the poorest quality housing to drop from the market. The off setting new construction, however, is built for the high-quality sector; the market therefore replaces the withdrawn low-quality units through a filtering process that gradually makes higher-quality dwellings available to lower-income households.

Finally, it is possible to compare household location without the program to that when the program is operational to see if allowance payments induce changes in discernible patterns. As one would expect in Green Bay, no definite patterns result because the zones are largely homogeneous.

Market Effects in South Bend

In South Bend, about 20.5 percent of the household population is designated income-eligible for a simulated open-enrollment housing allowance program. The 1980 values for C* are $168 per month for the non-elderly and $140 for the elderly households.[1] The minimum quantity of housing services is set at 91 units of service for the non-elderly and 76 units for the elderly families.[2]

Table 4 reports on program eligibility in South Bend. In 1980, South Bend's eligible population is represented by eight model households: three white non-elderly families, four white elderly households, and one black non-elderly family.[3] The composition of eligible households with respect to the non-elderly and elderly closely parallels current figures from the experiment. Minority eligibility is underestimated, however, by approximately 22 percent. Given the projected income distributions, the level of aggregation in the model and income-eligibility limits set by C*, there was nothing that could be done to reconcile this discrepancy.

The simulation results reported in Table 5 show that program participation in South Bend is high--between 75 and 100 percent of the eligible

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[1]The comparable cost figures for January 1976 reported in the Supply Experiment are $160 per month for the non-elderly and $130 for the elderly families. These cost figures are reported in Table 2.2 of Rand's Third Annual Report [19]. The projections show a three and a half year increase in costs of 5 percent for non-elderly and 8 percent for elderly families.

[2]Usually minimum housing standards are determined as the amount of services that the estimated cost of adequate housing would purchase at the new construction price, C*/Pn. In South Bend these housing standards were too high in 1980 given the implied market structure, so they were reduced to the same housing standards used in the 1960-1970 simulations, adjusted for price changes between the two decades.

[3]No elderly black households were included because the number eligible appears to be less than half the number represented by one model household (One model household represents approximately 1900 actual households in 1980).

Table 4

CHARACTERISTICS OF THE ELIGIBLE POPULATION IN SOUTH BEND, 1980

Type of Household	C* ($ per Month)	Annual Gross Income Limit	Minimum Quantity of Housing Services	Model Household Population			
				Number of Model Households	Percent of Eligible Population	Annual Gross Income	Monthly Subsidy
White non-elderly family	$168	$10,800	91	3	38	$7,340	$68
White elderly family	$140	$ 8,400	76	4	50	$4,713	$70
Black non-elderly family	$168	$10,800	91	1	12	$5,484	$96
Black elderly family	$140	$ 8,400	76	0	0	NA	NA

Note: NA indicates not applicable.

Table 5

SIMULATION RESULTS FOR SOUTH BEND, 1980

Measures	Supply Elasticity[a]	
	Inelastic	Elastic
Participation rate, percent	75	100
Average allowance per month, $	58	73
Earmarking ratios for participating households[b]	1.09	1.04
Expenditures	57	84
Quantity	24	53
Price	27	20
Expenditure change due to change in price	47	24
Eligible non-participating households		
Expenditures	-50	NA
Quantity	-23	NA
Price	-36	NA
Expenditure change due to change in price	72	NA
Near-eligible households[c]		
Expenditures	18	14
Quantity	8	11
Price	9	3
Expenditure change due to change in price	50	21
All households		
Expenditures	9	10
Quantity	4	7
Price	5	5
Expenditure change due to change in price	56	50
Additional withdrawals from the no-policy simulations	3	8

[a]Entries show percent increase for expenditures, quantity, price and withdrawals.

[b]The earmarking ratio is average expenditure change divided by average subsidy.

[c]Near-eligible households have incomes between the income limit for the program and 1.5 times that limit. Also included are non-elderly single persons with incomes below program limits.

NA indicates not applicable.

population. The average allowance payment to program participants ranges from $73 under elastic supply assumptions to $58 when supply is inelastic. Similar to the case of Green Bay, some households consume units below standards to take advantage of the large decrease in price that the program stimulates for substandard units. These households have the lowest income in their respective categories (white non-elderly families and white elderly households).

Again, the results show that the greatest market effects occur for the participating and non-participating eligible households. In South Bend, earmarking ratios are high; for each dollar of allowance provided, participating households are forced to spend between $.04 and $.09 of their own money that would have otherwise been allocated to non-housing consumption. The no-policy simulations for 1980 suggest that in the absence of an allowance program, 75 percent of the participating households would consume housing that failed to meet standards. When these households decide to participate, they must dramatically increase expenditures to obtain certifiable housing. The pressure that allowance standards place on the quantity of housing consumed is the primary reason for the large simulated earmarking ratios.

Those participating in South Bend's allowance program are subject to program-induced expenditure increases larger than those experienced in Green Bay. In South Bend, expenditures rise from 57 to 84 percent, depending on the type of supply assumption used: Inelastic housing assumptions show the smallest increase in expenditures; elastic supply assumptions bring a larger increase. The increased expenditures are attributable to a 24- to 53-percent increase in housing consumption and a 27- to 20-percent

increase in housing price.

Among the eligible households who do not participate under inelastic supply assumptions there is a 50-percent reduction in housing expenditures. Almost three-quarters of this reduction is attributable to a 36-percent decline in price.

Not surprisingly, the increased demand generated by the program puts pressure on those categorized as near-eligible. Although these households are almost totally unaffected by the program in Green Bay, they experience a 14- to 18-percent increase in expenditures in South Bend. These increases are caused by a 3- to 9-percent increase in the price of housing and an 8- to 11-percent increase in the quantity of units purchased.

Both sets of assumptions for supply produce similar results in the South Bend market as a whole: an increase in housing expenditures of nearly 10 percent, an increase in quantity of 4 to 7 percent, and a 5-percent program-induced rate of inflation. These increases, however, are limited almost entirely to the low-quality sector of the market where the program-eligible and near-eligible households find their housing.

With respect to the utilization of the existing stock, the allowance program increases the chances for unit withdrawals. Assuming an inelastic supply of housing, approximately 3 percent of the 1980 stock is withdrawn; with elastic supply assumption, 8 percent is withdrawn. There is a wide quality range for the new construction that replaces units withdrawn. Some of these units rank with the best of the existing stock. However, because of the minimum service requirements for newly constructed units estimated to represent zoning and building codes, no new construction is available in the quality sector where the participants find their housing. Thus, the participants in South Bend find replacements for the withdrawn stock through a filtering process.

A pattern of locational changes induced by the simulated allowance program can be seen more clearly in South Bend than in Green Bay. Once allowance payments are offered, some movement out of Zone 1 is indicated. This zone is the less affluent of the two central city zones where virtually all South Bend's minority population lives. This is not to imply that the model shows a mass exodus, but that Zone 1 loses approximately 10 percent of its population (one white model household).[1] Under both supply assumptions, the added income provided by the allowance payment permits participating white households to move out of the racially mixed Zone 1 to the white suburbs.

Differences between Green Bay and South Bend

The major differences between Green Bay and South Bend in their simulated responses to an allowance program are in participation rates and price increases. The South Bend simulations show substantially higher participation among those eligible and higher price rises among those participating than do the policy simulations for Green Bay.[2] These differences are examined through use of the price-structure curves introduced in Section III.

Figure 3 illustrates the housing markets in Green Bay and South Bend under the assumption of an elastic supply of housing. The curves defined

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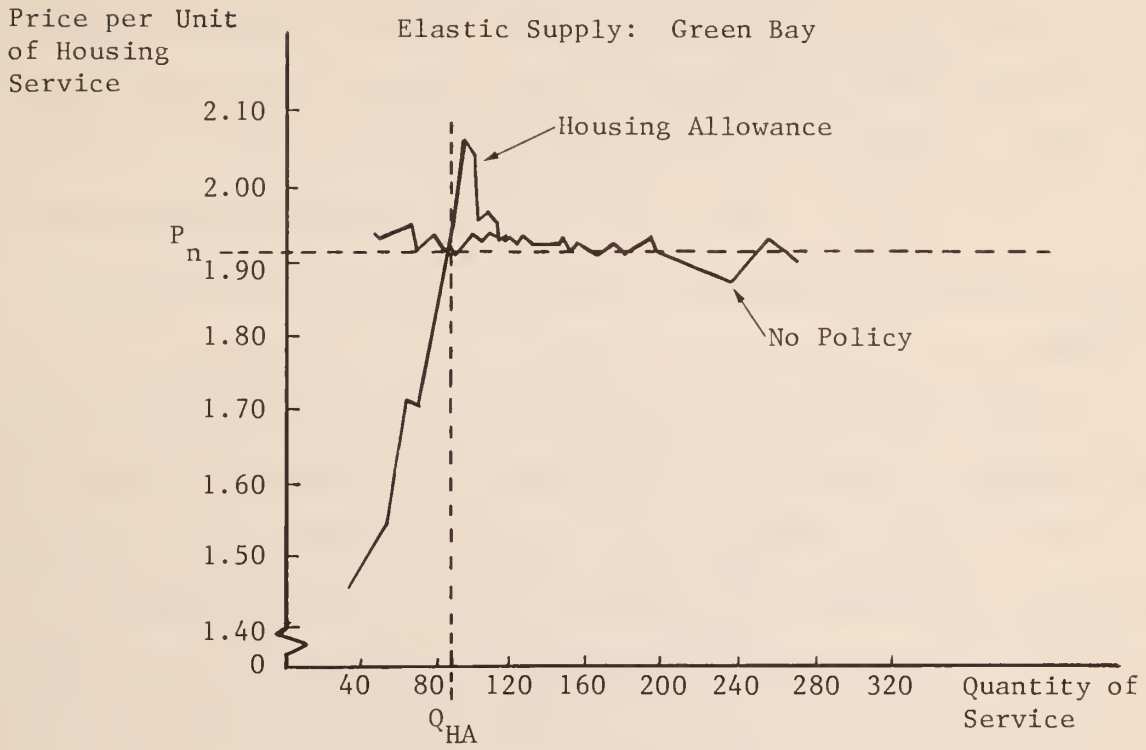
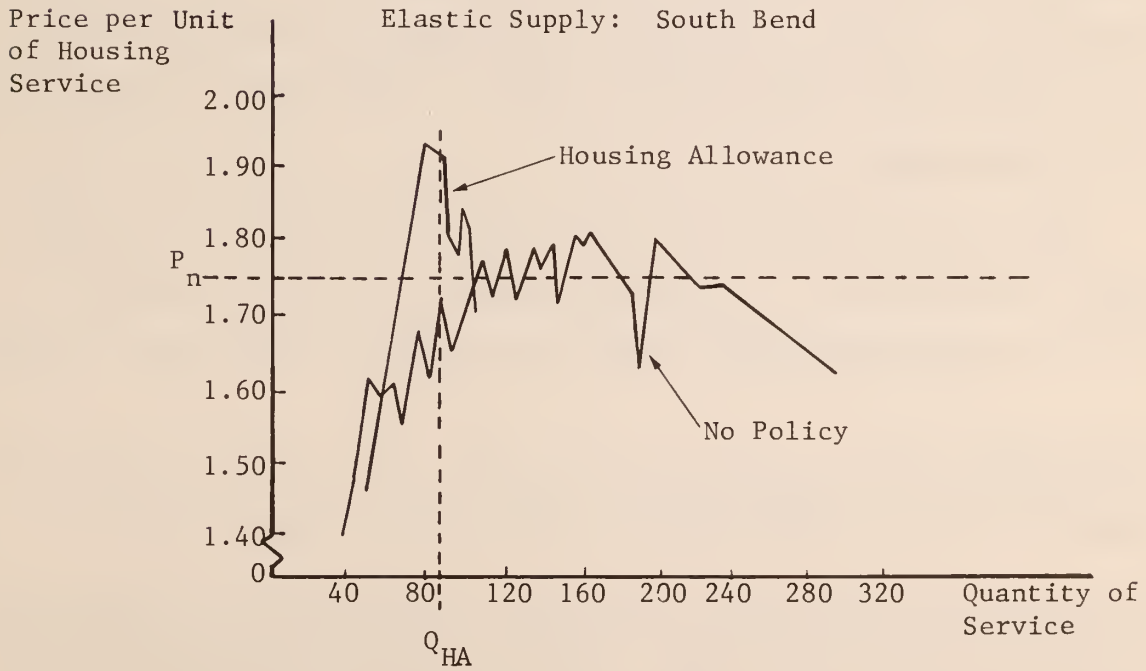
[1]New construction in the model is placed in a ubiquitous Zone 5. If only one of the new model dwellings were built in Zone 1, the market would be stable with respect to the center city. The quality level of the new units and the discounted stock in Zone 1 would probably work against the result. Intuitively, therefore, it is our best guess that the program would provide some households a chance to leave this area of the market.

[2]See Tables 3 and 5.

Figure 3. Effects of Housing Allowances on Price Structure: Green Bay and South Bend





by the thin lines--taken from Section III--describe the two markets in 1980 if there were no allowance programs in effect. In Green Bay, there is a strong demand for low-quality units; housing prices in that sector of the market, therefore, are close to new construction prices. The market in South Bend, however, shows substantial price discounting from the new construction price, P_n, caused by an excess supply of aging low-quality dwellings.

For both markets, the curves defined by the bold lines illustrate the price structure in the low-quality sector after a housing allowance program is introduced. The quantity level, Q_{HA}, is the minimum level of services required of enrollees in the allowance programs. Demand increases generated by housing allowances above these service levels are shown in the figures to produce a greater inflationary response in South Bend than in Green Bay. For the most part, Green Bay's increased demand is translated into movement along its price-structure curve.[1] For South Bend, increased demand has two effects. Prices increases first as a result of movement up along the curve; this movement then causes the curve to bulge upward, further adding to the price effects.

These results generally agree with the model's previous simulation runs. In applications to six other SMSAs for the 1960-1970 decade, as well as for four prototypical cities,[2] the model has consistently produced

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[1]The premiums paid per unit of housing service just above Q_{HA} result from the inability of new construction to supply this sector of the market because of apparent zoning regulations and building codes.

[2]The prototypical cities were constructed to represent all U.S. SMSAs over the 1960-1970 decade with regard to growth rate and minority proportions. A full description of the cities is given in de Leeuw and Struyk [4, pp. 121-127]. The prototypical cities have been used in most policy simulations with the model. The six SMSAs are described in Ozanne [9].

qualitative results on the inflationary impact of housing allowance programs that are similar to those for Green Bay and South Bend. An open-enrollment allowance program tends to eliminate any price discounting for low-quality units. The model therefore suggests that the degree of discounting is an important indicator of market price response to simulated allowance programs.

It can also be seen from Figure 3 that housing prices below program-imposed standards have been drastically reduced because of the program. In both markets, this results in some withdrawals from the existing stock of housing. Those units that remain, however, provide an inexpensive source of housing for some of the markets' lowest-income households.

In South Bend, where there is a 100-percent participation rate in the program, the model household taking advantage of the reduced cost of housing in this submarket is the non-elderly single-person household with the lowest income, which is categorically excluded from program participation. In Green Bay, three of the four households purchasing discounted housing found the program requirements too demanding and decided to forego their subsidies. These households are the least affluent of the eligibles. To participate in the program, their housing quality would have had to be increased by 75 percent on the average; their expenditure would more than likely increase by an even greater amount. This provides an example of how excessive earmarking can inhibit program participation.

V. ASSESSING MODEL PERFORMANCE

Section IV presented predictions about the effects of housing allowance programs in Green Bay and South Bend. This section compares those predictions to early findings from the Supply Experiment. The comparisons suggest that the predictions overstate the rate at which households participate in the program and the amount by which they improve their housing quality. We then use the findings from our comparisons to determine constraints for the housing allowance program represented in the model, and perform additional simulations. The revised simulations make it possible to predict market effects of housing allowance programs that are much more similar to those expected in Green Bay and South Bend in 1980. The section also provides a discussion of future modeling work.

Comparison of 1980 Model Predictions and Early Experimental Findings

The 1980 predictions differ from the early experimental findings for a number of reasons which can be grouped into four categories. The first arises because the experiment is still at an early stage; the other three, from the prediction process.

1. The 1980 experimental results can differ from experience observed over a shorter period. The latest information from the experiment used in these comparisons refers to 1976.
2. Projections to 1980 of model inputs may be inaccurate, e.g., 1980 population projections could be too high.
3. The model may inaccurately reflect the program implemented in the experiment, e.g., housing standards that are too high or

enrollment costs that are too low.

4. The model may inaccurately reflect the outcomes of supply and demand forces in the market, e.g., housing quality that is too low or prices that differ too much among subsectors.

Each comparison presented is analyzed with the four categories in mind. Emphasis is placed on the latter two model-related factors because the underlying purpose of the comparisons is to make an assessment of the model's performance. Of course, the model's assessment must remain tentative until information about 1980 experimental outcomes and model inputs is available.

From all the predictions made in Section IV, four are selected for discussions here: participation rates among eligible households, program induced changes in housing expenditures, housing consumption, and prices. These have been chosen because they highlight the major differences between the predictions and early findings from the experiment.

Participation. The comparison of participation rates suggests:

- Predicted participation is significantly higher than that reported in early findings from the experiment.

The predictions estimate 57-percent participation in Green Bay and 87- to 100-percent participation in South Bend. After two years of program operations in the experiment, the comparable participation rates are 35 percent in Green Bay and 26 percent in South Bend.[1] Furthermore, the non-participants in the predictions are the lowest income eligibles while non-participants in the experiment include many high- and low-income

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[1]Participation in this paper includes only those who are currently receiving payments. This differs from usage in the Supply Experiment where all enrollees are considered participants. Thus, participation rates reported here for Green Bay and South Bend are lower than participation rates reported by the experiment. The main explanation for enrollees not receiving payments in the experiment is that their housing has not passed standards. Experimental data are from The Rand Corporation [19].

households.[1] Homeowners, the working poor and the elderly are among the groups that are underrepresented in the experimental program.

The most obvious explanation for the difference would be that participation in the Supply Experiment has not yet reached its 1980 level. However, the participation rate has been stable in Green Bay for over a year, the rate in South Bend currently seems to be leveling off at about the same stage of program experience that it did in Green Bay, and knowledge of the program in both sites is already widespread, according to Rand surveys. Enrollment could still rise as households gradually repair their dwellings or move to program-approved housing, but the incentive for doing so will decline as the end of payments approaches. Another consideration is that the limited duration of the Supply Experiment may lower its participation rate from what would be expected in a national program.

If the current participation rate of the Supply Experiment is unlikely to rise greatly by 1980, the explanation for the difference in participation rates must lie in the predictions. One component of these predictions is the model's representation of housing allowances. As pointed out in Section IV, the representation of allowances is simplified and has never been calibrated against an actual allowance program. Of particular importance here, the participation decision in the model fails to consider many of the barriers posed by the enrollment process. These include learning about the program, taking the time to enroll, having household income verified and having housing inspected. Another barrier is the psychological stigma attached to being identified as a welfare recipient. The absence

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[1] In the experiment, higher income households, homeowners, the working poor, and the elderly are underrepresented at enrollment. The least affluent households are more likely to enroll but are less likely to obtain certified housing.

of these barriers in the model probably leads to an overstatement of participation among the higher-income eligible families who, in the experiment, appear to find the personal costs of overcoming the enrollment barriers greater than the value of their allowance payments.

The model's overprediction of participation can also be attributable partly to the failure to take account of moving costs. Those who fail program standards in the model are not deterred by the costs of moving to standard housing. This would tend to overstate households' rate of entry to a national program. The experiment, by contrast, may show an even lower participation rate than that expected in the first decade of an allowance program because it offers a limited future of benefits and possibly double moving costs. While the absence of moving and enrollment costs in the model may overstate actual enrollment in the Supply Experiment or even what it would be in the first decade of a national program, a better estimate of long-run or steady-state participation in a permanent national program may result.[1]

Housing Expenditures. Two conclusions stand out from the comparison of housing expenditures predicted with the model and what has been observed thus far in the experiment.

- The predictions show that the allowance program will result in a large increase in housing expenditures for program participants by 1980, but very little increase has

[1]Another explanation for higher predicted than experienced participation rates is that the eligible population in the experiment is overestimated. Eligibility in the experiment and the model is based on survey responses, while eligibility for the program is based on earnings and asset statements and verifications with employers, banks and tax returns. If survey-reported incomes are too low, eligibility is overstated in the experiment and participation understated.

been observed during the experiment's first two years.

- The predictions show more households would spend below the cost of adequate housing in the absence of the program than were doing so in the experiment at enrollment.

The allowance program is predicted to raise housing expenditures of program participants by 23 to 38 percent in Green Bay, and by 57 to 84 percent in South Bend. No analysis of program-induced expenditure increases is available from the experiment to date, but it seems that any increase must be small. One-half of the participants who rent in Green Bay and two-thirds in South Bend have had no rent increase after an average of about one year of program participation. Only the minority of renters who move show large expenditure increases, usually in the 15- to 40-percent range.[1] These reported rent changes are influenced by non-program factors like changes in family size and inflation, as well as any program effect. Expenditure changes for homeowners are not available, but the median cost of bringing an owned dwelling up to standards in both sites during the first half of 1976 was $11 or $12 for materials and a few hours of labor.

The smaller expenditure increases in the experiment occur even though the average allowance payments are larger than those estimated in the predictions. The result is that in the experiment most of the allowances are spent for household needs other than housing, thereby reducing housing cost burdens, while in the predictions, essentially all the allowances are spent on housing, leaving housing cost burdens unchanged.

The difference in housing expenditure increases between the 1980 predictions and early experiment experience seems to arise partly from

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[1] The Rand Corporation [18].

different levels of expenditure on housing prior to the program. The predictions estimate that at least 85 percent of the eligible households would spend less than the cost of standard housing, C*, for housing in the absence of the program. Early experience in the Supply Experiment indicates that only about 50 percent of enrolled renters were paying less than C* in their pre-enrollment housing.[1]

Further insight into differences between predicted and observed expenditure changes can be developed by examining the components of expenditure change; these are changes in the quantity of housing services consumed and in the price per unit of services.

Housing Consumption. The comparisons on housing consumption parallel those on housing expenditure:

- The predictions show that the allowance program will result in moderate to large increases in the housing consumption of program participants by 1980, while the experiment indicates little program effect after two years.
- The predictions show more households are failing housing standards in the absence of the program than are failing standards at enrollment in the experiment.

In the predictions, participants increase their housing by 18 to 27 percent in Green Bay; by 24 to 53 percent in South Bend. No comparable index of housing consumption is available yet from the experiment, but the preceding discussion about the absence of rent increases suggests that consumption improvements have been minor. Furthermore, in both

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[1]About 60 to 65 percent of homeowners pay less than C* in the experiment but these expenditures exclude foregone interest on invested equity. Data compiled by The Rand Corporation [18].

sites of the experiment about half of the enrollees needed no improvement in their pre-enrollment housing to pass program standards and about another 40 percent needed to spend only a median of $11 to $12 and a few hours of of labor to pass standards.

One explanation of the difference in housing quality improvement between 1980 predictions and current experience would be that many housing improvements are slow to occur in the experiment. Households with the lowest-quality housing initially could take longer to obtain acceptable housing, and those who pass standards initially still would eventually use some of their allowance to improve their housing. Nevertheless, gradual housing improvement in the experiment is not likely to reach the predicted levels by 1980. One reason is that the average quality of potential participants' housing in the experiment appears to be only slightly worse than that of current participants. Of the non-participants, some have enrolled in the program but failed to pass program standards. These non-participants typically failed the standards for reasons similar to others who upgraded their dwellings for modest outlays of money and time. The other non-participants are those who never enrolled. Their housing may be better than that of participants, on average, since non-enrollees tend to have higher incomes.

Current program recipients will probably not spend enough of their allowances on future housing improvements to match the improvements of the predictions. The simple income effect of the allowances is likely to increase housing consumption by less than 13 percent in Green Bay and less than 18 percent in South Bend, according to analysis based on Demand

Experiment evidence.[1] In both sites, these upper bounds on quality increases are below the lower estimates from the housing model's predictions.

Since the experiment is unlikely to achieve all the increases in housing quality predicted by 1980, the estimated increases must be too high. In this regard, the predictions show an important difference from early experience in the Supply Experiment. The model results show at least two-thirds of the would-be program recipients consuming below simulated housing standards in the absence of the program. Most of the housing quality improvement in the predictions occurs as these households upgrade their housing to meet standards when the program is simulated. In contrast, about 90 percent of program recipients in the experiment passed program standards in their pre-enrollment housing with minimal upgrading. Thus, compared to early experimental results, the predictions show too great a housing gap between housing quality without the program and program standards. This overstatement of the housing gap must be a major contributor to the overestimate of housing quality improvement in the predictions.

Too large a housing gap can occur because modeled program standards are too high or predicted housing quality in the absence of the program is too low. Modeled program standards do not seem to be too high, but as Section IV points out, it is not possible to make a definitive comparison between the housing quality standards of the model and those of the experiment. The conclusion here about the approximate equivalence of the two

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[1] The percent changes in housing consumption are calculated by assuming that allowances increase incomes by less than 20 percent in Green Bay and less than 28 percent in South Bend and that there is an income elasticity of .667. The income increases are interpolated from a table in The Rand Corporation [18], and are treated as permanent additions to income. The income elasticity is the long-run income elasticity for Pittsburgh reported by Friedman and Weinberg [5]. Their long-run income elasticity for Phoenix is .549.

sets of standards is based on a comparison of how much it costs to rent housing that meets those standards. Dwellings passing housing standards in both the experiment and the predictions rent for close to the estimated cost of standard housing, C*, in each.[1] Because the 1980 C* values used in the predictions will most probably be below the 1980 C* values in the experiment, it seems unlikely that the predictions' standards are much above those imposed in the experiment.

To the extent that housing standards are roughly comparable between the predictions and the experiment, the larger housing gap in the predictions must arise from an underestimate of housing quality in the absence of the allowance program. Inaccuracies in the inputs to the model or errors in the model's estimate of basic market trends over the 1970s could account for such an underestimate. Until 1980 values for inputs are known, it will be impossible to determine how much of this underestimate is attributable to the model itself.

Housing Prices. The findings of the housing price comparisons differ between Green Bay and South Bend:

- In Green Bay, the allowance program is predicted to raise prices slightly for allowance recipients and not at all for the rest of the market by 1980. The experiment has found no program-induced increases after 18 months.
- In South Bend, the allowance program is predicted to raise prices sharply for allowance recipients and slightly for those with incomes just above the eligibility limit. The experiment has found no program-induced price increases after 27 months.

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[1] Dwellings passing standards in the experiments show a rent distribution around C*, indicating some differences in the total level of services included with the program-required services and other differences in the prices paid for similar services. Still, few dwellings passing standards rent for much below standards.

The predictions for Green Bay show that the allowance program causes a 4-percent price increase for allowance recipients under the elastic assumption and a 9-percent increase under the inelastic one. Essentially no increases occur for the remainder of the market. Analysis from the experiment is tentative but generally consistent with the predictions. Rent increases in the first 18 months of the program for both recipients and non-recipients are attributed to factors other than the allowance program--largely utility price increases.[1]

The predictions for South Bend show that the allowance program will cause substantial price increases for allowance recipients by 1980 (20 to 27 percent) and small increases for households just above the income eligibility limit (3 to 9 percent). There was no evidence of program-induced price increases reported in the first 27 months of the experiment.[2] Large price increases resulting from the experiment in South Bend are unlikely as long as the program-induced demand for housing remains much smaller than that in the predictions. The previous discussions of participation and housing quality indicate that large increases in program-induced demand are unlikely.

The large price increase predicted with the housing model arises because of the large increment to demand which is being focused on an otherwise depressed sector of the market. As was explained earlier, the model predicts extensive price discounts in the low-quality sector of the South Bend housing market in the absence of the allowance program and imposition of the large program in the simulations tends to eliminate these discounts.

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[1] Alesch and O'Neil [1, pp. 12-13].

[2] Stucker [16, p. 51].

Observation of price discounting in South Bend would support the model's simulations and add some credibility to its prediction that substantial price increases would accompany large increments in housing demand. The only empirical evidence on discounting in South Bend comes from a study of rental properties in Green Bay and South Bend.[1] That study finds negligible discounting of rents in South Bend, but finds that the values of rental properties are substantially discounted. Long vacancies that reduce rental revenue are generally found to reduce the value of rental properties. Why these vacancies do not affect rent is unexplained. Although the study does not consider the price of owner-occupied homes, they are probably discounted similarly to rental property. The reason is that single-family homes make up most of the stock of tenant- and owner-occupied housing and must sell for similar amounts in the two markets. Thus, as about one-half of all program-eligible households are homeowners in South Bend, it is possible that they face a form of price discounting. Furthermore a program that provides a large increase in demand, especially if it reduces vacancies in rental properties, could well result in increases in the price of housing--if not in rentals.

Summary of Comparisons. The predicted housing allowance program for 1980 results in higher participation rates and larger increases in recipients' housing consumption than seems likely to occur in the Supply Experiment. This greater participation and housing improvement in the predictions reflects a stronger stimulus to demand than is occurring in the experiment. For Green Bay, the simulated shift in demand results in minor price increases for recipients and none for other households. This market effect is consistent with the early experimental evidence in Green Bay.

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[1] Rydell [10, pp. 5-7, 10-11].

In South Bend, the stimulus of the predictions leads to substantial price increases for recipients and small increases for households whose incomes are just above the income cutoff. Program-induced price increases have not been observed in South Bend.

These comparisons can be useful in assessing the performance of the model, i.e., how well the model's housing allowance represents actual housing allowance programs. Preliminary indications from the comparisons indicate that the model's representation of housing allowances overstates the willingness of households to participate, particularly those with higher incomes. Also, the model probably understates basic trends in housing consumption over the decade. These two factors contribute to overstatement of program-induced demand for housing which, in turn, results in substantial price increases in South Bend, though not in Green Bay. In reality, such increases are unlikely to occur in South Bend because of the smaller program effects of the experiment. It remains to be seen whether simulation of a program like the experiment's would produce negligible price increases, or whether a program as large as that used in the simulations would produce sharp price increases if implemented in South Bend. The remainder of this section touches upon the former issue, while the latter must be addressed through analytical studies of the sites.

Simulating Market Impacts of the Supply Experiment

It is possible to constrain the model to create an allowance program that more closely resembles the participation, housing consumption and price responses expected in the Supply Experiment by 1980. The purpose of these new, constrained simulations is to test whether the model can

predict the market effects of an allowance program once it accurately portrays the demand stimulus introduced by that program. The success of the predictions provides some notion of the improved accuracy to be derived from modifying the model's portrayal of participation and earmarking. It should be noted, however, that the constraints themselves do not represent an improved model; they are merely restrictions imposed on currently modeled behavior.

In the constrained simulations, only a subset of the eligible households is allowed to participate. They are selected to reflect as nearly as possible the characteristics of the families actually participating in Green Bay and South Bend. The selection criteria include the number, age, and race of households and ratios between their income, rent and allowance entitlements. The households allowed to participate in these simulations do so only if it is to their advantage to do so.

Table 6 illustrates how participants in the experiment compare with those in the new simulations. For Green Bay, the experiment and the model show similar results for most measures. For South Bend, the model shows a higher maximum participation rate, while the number of participant households with black and elderly heads of households is lower. These differences should lessen over time as enrollments increase in South Bend's suburbs which delayed entering the program. Differences in the proportion of elderly participants are unlikely to be reduced substantially over time; these differences were unavoidable because of the aggregation of the model.

The constrained simulations reflect a much smaller gap between program housing standards and the housing that eligible households consume in the absence of the program. Program standards are lowered in the model

Table 6

CHARACTERISTICS OF PARTICIPANTS IN THE SUPPLY EXPERIMENT AND IN THE CONSTRAINED SIMULATIONS OF THE EXPERIMENT, GREEN BAY AND SOUTH BEND

Measures	Green Bay		South Bend	
	Experiment	Model	Experiment	Model
Participation rate, percent[a]	35	43	26	50
Participants by household type, %				
Elderly head of household	36	33	40	25
Black head of household	1	(b)	40	25
Average allowance per month, $	77	78	72	87
Rent-income ratio	.25	.30	.25	.26
Subsidy-income ratio	.15 - .20	.25	.20 - .30	.27

[a]The numbers for the model are maximum participation rates. Participation is defined as the number currently receiving payment. This is to maintain comparability between the model and the experiment. Participation is generally defined by the Supply Experiment as enrollment in the program.

[b]Model households in Green Bay are not categorized by race.

NOTE: The characteristics of the participants in the experiment are interpolated from The Rand Corporation [18], except for racial composition which is taken from Third Annual Report [19]. The characteristics of the participants in the model are tabulated from model simulations.

so that two-thirds of the participants in Green Bay and three-fourths in South Bend pass standards in the housing they would occupy in the absence of the program.[1] The remainder of the participants occupy housing that is considerably below standards. (Recall that in the experiment about half the enrollees pass standards with no change in their pre-enrollment housing and another 40 percent pass with mostly minor repairs.)

The market impacts of these constrained simulations are reported in Table 7. Participation rates among all program-eligible households are 43 percent in Green Bay and 50 percent in South Bend, indicating that all households allowed to participate do so. The characteristics of these participating households now resemble those of participants in Green Bay and South Bend to the extent described in Table 6.

The reduced housing standards in these constrained simulations put relatively little pressure on households that already pass standards to increase housing expenditures. More similar to findings from the Supply Experiment, these simulations show substantially less earmarking for program participants: .09 to .13 in Green Bay and .29 to .33 in South Bend. Thus, housing allowances in these simulations are used predominantly to reduce housing cost burdens.

The inelastic and elastic supply assumptions yield a narrow range of expenditure, quantity and price increases for participating households in the constrained simulations. For Green Bay, program-induced expenditure

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[1] Although the model's housing gap has been reduced by lowering housing standards in these simulations, it could also be accomplished by raising the housing consumption of families in the absence of the program. That, however, would require more extensive changes in the basic model or very different projected input values for 1980.

The new quality standards are 72 units of service in Green Bay for the non-elderly and 48 units for the elderly; the figures for South Bend are 52 and 39 units.

Table 7

CONSTRAINED SIMULATION RESULTS: REDUCED PARTICIPATION AND STANDARDS, GREEN BAY AND SOUTH BEND

Measures	Supply Elasticity[a]			
	Green Bay		South Bend	
	Inelastic	Elastic	Inelastic	Elastic
Participation rate, percent	43	43	50	50
Average allowance per month, $	78	78	87	87
Earmarking ratios for participating households[b]	.09	.13	.33	.29
Expenditures	6	8	33	27
Quantity	3	4	21	16
Price	2	4	10	9
Expenditure change due to change in price	33	50	30	33
Eligible non-participating households				
Expenditures	2	5	-28	-15
Quantity	1	2	-20	-12
Price	1	2	-11	- 3
Expenditure change due to change in price	50	40	39	20
All households				
Expense	0	0	- 1	0
Quantity	0	0	0	0
Price	0	0	0	0
Expenditure change due to change in price	NA	NA	NA	NA
Additional withdrawals from the no-policy simulations	0	0	0	0

NOTE: Results reported here are comparable to the simulations in Tables 3 and 5.

[a]Entries show percent increase for expenditures, quantity and price.

[b]The earmarking ratio is average expenditure change divided by average allowance.

NA indicates not applicable.

increases range from 6 to 8 percent, while South Bend's are somewhat higher, 27 to 33 percent. The difference between the sites is consistent with the original simulation findings, though at a lower level. As anticipated, those households failing to pass even the new standards are the ones that face the highest expenditure increases.

Another factor that contributes to expenditure increases in the new simulations is the Supply Experiment's requirement that participating households have housing expenditure payments at least equal to their allowances. This requirement creates a strong incentive for recipients spending less than their allowance to increase their expenditures up to the amount of their maximum entitlement. These increases are fully paid by the higher allowances. The model shows that some households in both sites have pre-allowance housing expenses below their maximum allowance level when they become eligible for housing allowances, and these households increase their expenditures to the amount of their maximum allowance.[1]

The reduced increase in housing expenditures in these simulations is the direct result of the low price and quantity increases. In Green Bay, there is only a 2- to 4-percent increase in price and 3- to 4-percent increase in quantity consumed by participating households. In South Bend, the comparable figures show a 9- to 10-percent increase in price and a 16- to 21-percent increase in quantity.

The decline in participation and in housing standards for these simulations makes it more difficult for those eligible but not participating

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[1]There is an exception to this finding for the lowest-income model household in Green Bay under the inelastic supply assumption. This household has pre-enrollment housing that is four units above its program standard. It finds that by reducing its quality level to standard, it can reduce its expenditure level by 13 percent, while still retaining most of its allowance. The expenditure reduction for this household explains why the reported inelastic expenditure increase is less than those reported for the elastic.

to take advantage of price reductions for low-quality units. In Green Bay, none of these higher-income eligible households choose to reduce their quantity below the new standard requirements. In fact, the allowance program slightly increases demand in the sector of the market where these households generally purchase housing. They are therefore induced by the program to increase expenditures from 2 to 5 percent and face a 1- to 2-percent increase in quantity and price. In South Bend, 50 percent of the eligible non-participating households find inexpensive housing below program standards. Taking advantage of the reduced demand and price decreases for these units, these households experience a 15- to 28-percent decrease in expenditures comprised of a 12- to 20-percent reduction in quantity of services and a 3- to 11-percent decrease in price.

Table 7 also demonstrates that the smaller simulated allowance programs have virtually no impact on the entire housing market. Overall, the market effects are concentrated among the lower-income groups.

The predictions of market effects based on the constrained simulations appear to be close to those emerging from the Supply Experiment. Among recipients, housing quality improvements are small to moderate; price inflation is small; and most of the allowance payment goes into non-housing consumption. Among other households, no price increases are felt. An important prediction that remains from the unconstrained simulations is that housing expenditure increases will be larger in South Bend than in Green Bay. Another prediction similar to that in the unconstrained case is that many eligible non-participating households in South Bend will occupy housing below standards at considerably lower

cost than typical standard housing. These predictions need to be tested with experimental findings.

Implications for Future Modeling Work

This paper has begun the process of evaluating and strengthening the Housing Market Model with the results of the Housing Allowance Supply Experiment. The implications for further work follow from what has been learned so far.

One implication is that the evaluation needs to be completed once 1980 data are available. The 1980 Census data will permit an accurate portrayal of model inputs such as 1980 populations, incomes and new housing prices; it also will permit recalibration of the model in each site to determine the appropriate parameters for the 1970s. The Supply Experiment's 1980 program records and late 1970s survey data will permit a direct evaluation of the model's performance in the prediction process, using actual 1980 participation rates, estimates of program-induced changes in housing quality and prices, and measures of price discounting.

From the initial evaluation of the model in this paper, several implications for strengthening the model emerge. The representation of government programs in the model--in this case housing allowances--needs to be calibrated against actual program experience. In particular, the household's participation decision must be more accurately represented. The results of the Demand Experiment as well as the Supply Experiment will be important for this work. Also, the model's predictions of basic trends in housing consumption and prices may need improvement, depending on 1980 data analyses about the accuracy of predictions on housing

consumption levels and about housing price discounting. Finally, the wide range of supply elasticity parameters used in the model can be narrowed through use of the direct econometric estimates from the Supply Experiment.

The future work implied by this initial evaluation is limited in scope and could be accomplished with minimal additional effort beyond what is already in the existing research agendas of the individual experiments. Yet this work would be used widely as the model is used in the evaluation of many housing policies and as it is an important step in the process of learning about and building better housing market models.

Other implications for strengthening or even rebuilding the model are likely to emerge as the results of the Supply Experiment become known. The value of undertaking these changes will have to be assessed at that time. Examples of areas in which the experiment could show the need for improvements are additional detail in the representation of housing suppliers (e.g., owner-occupants and landlords), in the representation of neighborhoods (smaller areas identified), and in the classification of households (welfare recipients, homeowners).

Finally, at some point it may be desirable to calibrate the model to a range of metropolitan areas for the 1970 decade to simulate the effects of alternative housing policies. For example, housing allowance programs could be simulated in order to predict the effect of an open enrollment program in urban areas other than Green Bay or South Bend.

Appendix

MODEL INPUTS FOR THE 1970-1980 PROJECTIONS

The simulations reported in this paper rely heavily on the 1960-1970 model calibrations for Green Bay and South Bend. The division of the SMSAs into geographic zones, the estimated travel times between zones, and household, landlord and builder behavior have remained unchanged from previous simulations of the model. A thorough description of these inputs can be found in earlier papers.[1] This appendix focuses on model inputs generated specifically for the 1970-1980 projections, including descriptions of the 1970 housing stock, projections of the 1980 household populations and income, and the price per unit of service for new dwellings over the decade.

Zone Descriptions

Housing markets are typically comprised of submarkets, each of which demonstrates, to some extent, its own supply and demand conditions. The division of a housing market into submarkets according to housing quality depends on both the physical and locational characteristics of dwellings. To accomplish this division, prior to fitting the model to an SMSA, a housing market generally is divided into geographic zones that are homogeneous with respect to the neighborhood characteristics used in the model--travel time to and from place of employment, affluence, and racial composition.

Table A-1 and Figure A-1 describe the market characteristics of Green Bay's model zones. The city of Green Bay (1960 boundaries) is divided into Zones 1 and 2. Zone 1 contains the census tracts that border the Fox River--

[1] See Vanski [20] and Marshall [6].

Table A-1

1970 MARKET CHARACTERISTICS: MODEL ZONES OF GREEN BAY AND SOUTH BEND

Market Characteristics	Green Bay SMSA (zones)				South Bend SMSA (zones)			
	1	2	3	4[a]	1	2	3	4
Number of housing units	12,179	13,110	19,509	--	17,777	23,560	14,994	19,260
Built before 1959	10,967	9,882	12,062	--	17,126	21,225	11,513	12,712
Built 1960 or later	1,212	3,228	7,447	--	651	2,335	3,481	6,548
Annual income[b]	$ 7,210	$ 9,224	$ 9,917	--	$ 6,700	$10,900	$ 8,200	$ 8,700
Value of monthly housing services[c]	$116	$123	$142	--	$95	$139	$123	$151
Proportion with black head of household[d]	--	--	--	--	0.24	0.03	0	0.01
Average travel time to work[e]	6	7	11	--	6	7	9	14

SOURCE: U.S. Bureau of the Census, Census Tracts: Green Bay, Wisconsin, Standard Metropolitan Statistical Area, and Census Tracts: South Bend, Indiana, Standard Metropolitan Statistical Area, PHA (1), U.S. Government Printing Office, Washington, D.C., 1972.

[a]Green Bay is represented by three zones.

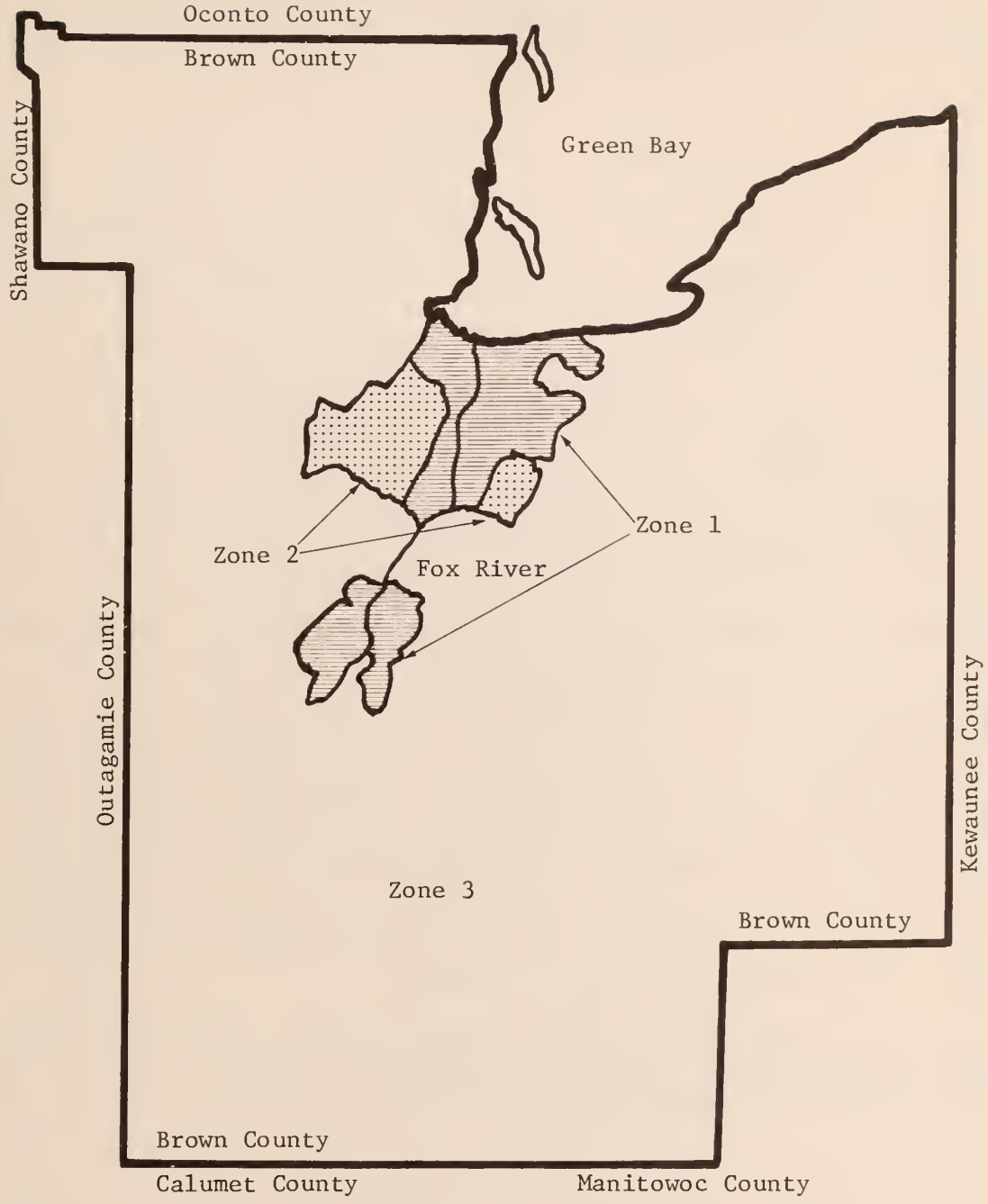
[b]Average per household.

[c]Average per household.

[d]EHAP data provide information for South Bend only. There is no racial disaggregation in Green Bay.

[e]Minutes traveling one way.

Fig. A-1. Green Bay SMSA: Model Zones



included in this zone is the city of DePere. In 1970, this zone was typified by an older stock of housing that supplied a relatively low level of housing services and attracted the lower-income households within the SMSA.[1] Zone 2 was by far the more affluent of the two urban zones; 25 percent of its stock was constructed during the 1960s; and its quality was significantly higher than that found in Zone 1.

Zone 3, which contains the remaining 44 percent of the housing stock in the SMSA, is made up of areas annexed by the city since 1960, all suburban areas and all rural areas. In the housing model, an SMSA is usually divided into four zones representing more and less affluent, urban and suburban areas. This was prohibited in Green Bay because, except for the 1960 city of Green Bay itself, the SMSA was not divided into census tracts. The 1980 model projections follow this three-way division because the behavioral parameters were estimated by matching actual zone characteristics to simulated model output using the earlier geographic divisions. Thus, Zone 3 is a conglomerate of the more and less affluent suburban census tracts.

Yet, despite its diverse stock, Zone 3 demonstrates higher average incomes and levels of housing services than either urban zone. In 1970, 38 percent of Zone 3 housing stock was newly constructed, this being 63 percent of all units built during the 1960s.

The South Bend SMSA--excluding Marshall County, which has not been included in the Experimental Housing Allowance Program--has been divided into four zones, as described in Table A-1 and Figure A-2. Zone 1 is South

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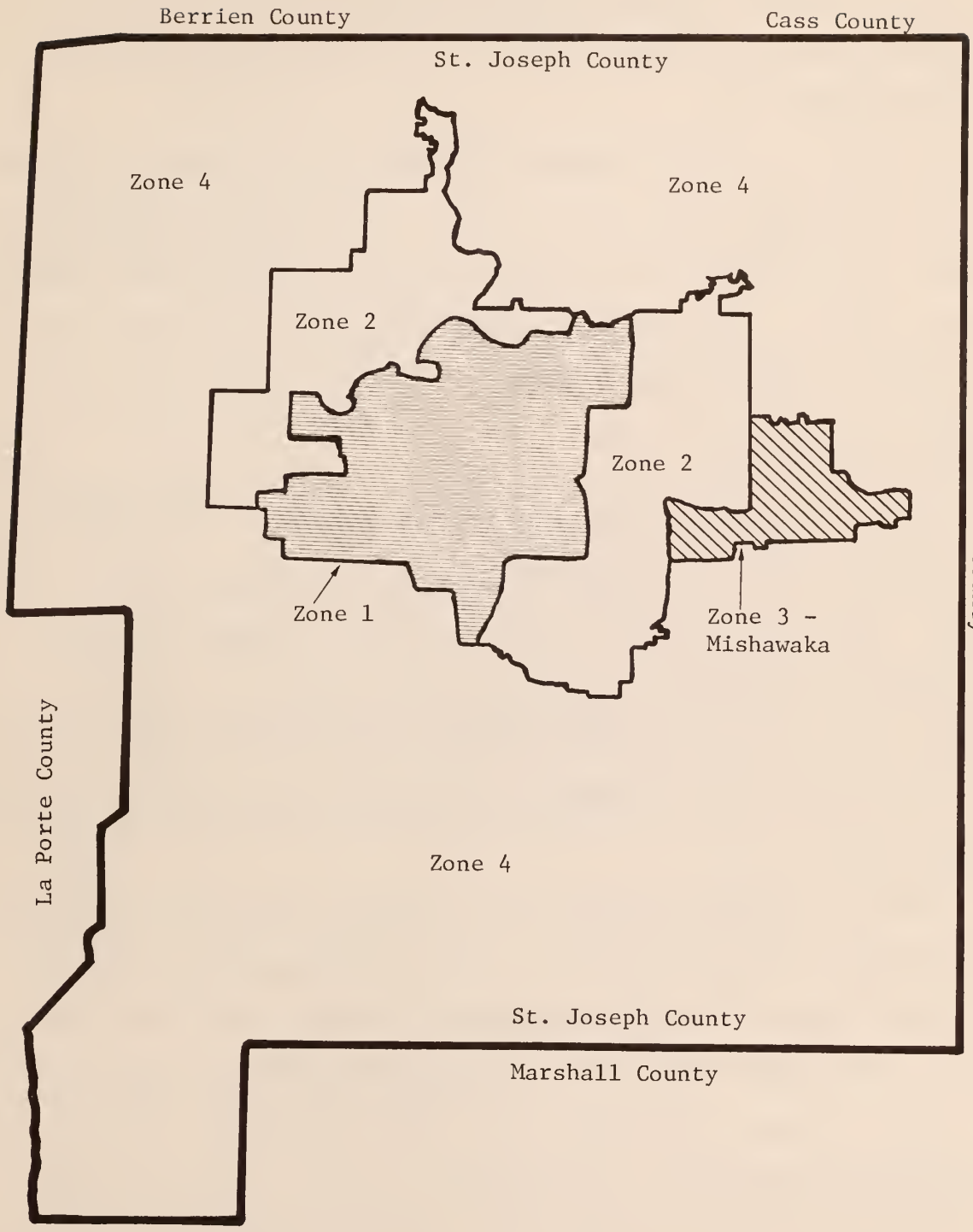
[1]The value of housing services is used to assess the quality of housing in each zone. The technique used to arrive at these figures is to calculate a hedonic regression using data from the 1970 Public Use Sample. The regressions relate the gross rent on value of a dwelling to its physical characteristics; the coefficients represent imputed prices. These coefficients are then used with the average dwelling characteristics of each zone to determine the zone's average quantity of services. See de Leeuw and Struyk [4, pp. 62-70].

Fig. A-2. South Bend SMSA: Model Zones



Bend's center-city; it is a low-income area with a high concentration of blacks and an older, poorer quality housing stock. The remainder of the city, Zone 2, is more affluent than its counterpart and almost exclusively white. Its housing stock is of higher quality, yet only 10 percent was built during the 1960s.

Seventy-seven percent of all new construction in the 1960s is located in the two suburban zones, Zone 3, representing the city of Mishawaka, and Zone 4. Although there is not much difference in household income between these two zones, Zone 4 contains a newer stock of housing; 34 percent of its stock was built during the 1960s.

Behavioral Parameters

The reliability of the model projections depends to a great extent on the assumptions that govern household and supplier behavior for the 1970 decade. While the parameters governing household consumption behavior could have been reestimated using more current data than those used in previous simulations, the supply parameters, which assume household behavior as given, could not be reestimated because of the lack of 1980 data on market characteristics.[1]

Table A-2 provides a summary of the parameter values used in the 1970-1980 housing allowance simulations. The α parameters, which vary by household type, express household preferences for housing versus other goods and services; the higher the α value, the more the household is willing to spend on housing. Roughly approximated, the α can be considered as ratios of housing expenditures to incomes.

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[1]The estimation of these parameters is described in Vanski [20, pp. 10-31] and Marshall [6, pp. 9-33].

Table A-2

SUMMARY OF PARAMETER VALUES FOR 1970-1980,
GREEN BAY AND SOUTH BEND

Parameters	Green Bay	South Bend
Ratios of housing expenditures to income (α)		
$\alpha(1)$ White non-elderly	0.16	0.15
$\alpha(2)$ Elderly single	0.26	0.25
$\alpha(3)$ Black non-elderly[a]	--	0.17
$\alpha(4)$ Black elderly, single[a]	--	0.26
Other parameters of household behavior (γ)		
$\gamma(1)$ Price responsiveness	0.9	0.6
$\gamma(2)$ Zonal wealth	0.4	0.6
$\gamma(3)$ Zonal racial mix	0.8[b]	1.0
Supply parameters (β)		
Elastic supply		
$\beta(1)$	0.4	0.3
$\beta(2)$	1.0	1.0
Implied elasticity at new construction price	1.07	1.27
Inelastic supply		
$\beta(1)$	0.6	0.7
$\beta(2)$	0.7	0.6
Implied elasticity at new construction price	0.75	0.67
Travel times to and from place of employment (hours per month)		
Zone 1	4	4
Zone 2	5	5
Zone 3	7	5
Zone 4	--	9
Zone of new construction	7	12

[a]There is no racial disaggregation in the Green Bay SMSA because of the small number of minority households.

[b]Because there is no racial disaggregation in Green Bay, 0.8 represents an average value over model runs in other sites. It is a proportional adjustment across households and in no way affects the ordering of household preferences within the market.

The stability of these ratios in the past has made them useful in quantifying the parameter defining housing preferences. Data for the 20-year period between 1950 and 1970 suggest that Americans were spending a relatively constant percentage of their income on housing. This was the result of a slight decrease in the percentage spent on housing expenditures within classes of households and a shift in the composition of households toward those groups that tend to spend more on housing, namely the elderly and families headed by females and single persons.[1]

The economic structure supporting these parameters began to change in the late 1960s, which made it difficult to assume that there would be no compensating changes in consumer attitudes toward housing by 1980. Departures from past trends found the cost of housing beginning to exceed income increases. The short-run response by consumers--who were temporarily locked into housing situations--has been to increase expenditures relative to income.[2] The current relationship between prices and incomes will more than likely persist throughout the current decade. However, there has been some indication that there may be a long-run adjustment in quality as consumers adhere to past expenditure preferences vis-a-vis higher prices.[3] Given the conflicting evidence and an inability to separate the long-run from the short-run experience, a decision was made to retain the 1970 values of α in 1980.[4]

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[1] See de Leeuw, Schnare and Struyk [3 , pp. 120-129].

[2] The increase has been documented for the 1970-1973 period in Sternleib, Burchell and Listokin [11].

[3] See de Leeuw, Schnare and Struyk [3 , pp. 134-141].

[4] Other 1980 housing simulations have been run with the assumption of an increase in α parameters. See Struyk and Marshall [14 , pp. 31-34].

The γ parameters in Table A-2 cannot be estimated by conventional statistical techniques; instead, they are determined by running the model using various parameter values to determine which combination best matches the housing stock with households at the beginning of the decade. γ_1 is a measure related to the substitutability of housing across submarkets, indicating the degree to which a household will alter its housing consumption in response to price. The value of γ_1 can vary between zero and one; zero indicates maximum responsiveness. γ_2 is a measure, other things equal, for a zone with high average net rent per household; this parameter serves as a proxy for the attitudes of households toward the wealth of the zone in which they live. The last parameter, γ_3, indicates household preferences toward the racial composition of the zone. The higher the γ_3, the stronger the desire for the household to live among members of its own race.

As mentioned, an a priori decision was made not to adjust these three γ parameters from their 1960 decade values because there are insufficient data to reestimate the other parameters for 1980. The γ values were recalculated, however, to determine how much they would have changed using 1970 data. In both sites, the model sought to maintain its γ_2 values; in South Bend, where race plays an important role, γ_3 would have remained unchanged. Not surprisingly however, the model sought to reduce γ_1, the cross-elasticity of demand for different qualities of housing. In Green Bay, 1970 base year runs would have yielded a value of 0.8 for γ_1; in South Bend, γ_1 reached 0.4. These should be compared to 1960 values of 0.9 in Green Bay and 0.6 in South Bend. Faced with increasing prices and declining incomes, this reduction in γ_1 could be interpreted as a tendency of households to accept

lower-quality levels of housing services.[1] By retaining the higher values of γ_1 from previous runs, we have, in essence, limited household choice and decreased interaction among housing submarkets.

The β parameters govern the behavior of owners of the existing housing stock. Both β_1 and β_2 are best understood in terms of their effects on the ratio of the quantity of housing services at the end of a decade to housing services at the beginning of the decade. This ratio, Q/Q_o, is defined by the model as:

$$Q/Q_o = \beta_1 + 2/3\ \beta_2 \left[\frac{P - P_o}{P_c} \right]$$

where P is the price per unit of service offered by a dwelling; P_o is the operating cost per unit of service; and P_c is the capital cost per unit of service of a new dwelling.[2] From the above equation it can be seen that β_1 represents the deterioration rate of a dwelling operating at a price just sufficient to cover operating costs. The second parameter, β_2, indicates how the quantity ratio, Q/Q_o, responds to the price of housing services.

The β parameters, like the γ parameters, are estimated through repeated simulations; ideally, the β values chosen would be the ones that best replicated end-of-decade market conditions. Without data on the 1980 zonal characteristics such as average household income, housing expenditures, and the rate of utilization of the 1970 housing stock, however, reestimation is impossible.[3]

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[1] See the discussion of the α parameters earlier in this appendix.

[2] For a discussion of supply functions used in the model, see de Leeuw and Struyk [4, pp. 26-28].

[3] For details on estimation of supply parameters, see Marshall [6 , pp. 20-33] and Vanski [20, pp. 20-31].

Consequently, a range of β values, obtained from calibrating the model for the 1960s, is used to provide a range of market conditions from a relatively inelastic to an elastic existing housing stock. In Green Bay, the estimated range of supply elasticities is 0.75 for inelastic parameters and 1.07 for elastic parameters; for South Bend, this range is from 0.67 to 1.27. This estimated range of β values should encompass any shifts in actual market parameters over the 1970s.

Distribution of Housing Services

The model is provided initially with a start-of-decade distribution of housing services among its zones. These services refer only to characteristics supplied by dwelling unit structures; the three neighborhood attributes are either supplied exogenously (as in the case of travel time) or endogenously (zonal wealth and racial composition). The derivation of service distributions therefore requires the development of price deflators that convert rents and values to location-free measures of the quantity of services; these deflators are used, together with rent and value data, to construct model dwellings that represent the initial housing stock.

To quantify explicit neighborhood effects and eliminate them from rents and values, regression analysis was applied to microdata from the 1-in-100 sample of the 1970 Census Public Use Sample for metropolitan dwellings in Indiana and Wisconsin. The "hedonic" regressions were run separately in each state for renters and owners and related the rent or value of each unit to physical characteristics such as number of rooms, presence of central heat, year in which the structure was built, and neighborhood characteristics including race of the household head and location in the central city.[1]

[1]For a description of methodology and data used in the "hedonic" regressions see Struyk and Marshall [13].

Structural coefficients from these regressions were then applied to census data aggregated across the specified model zones to establish estimated rents and values for structural services. The ratio of actual average rents per dwelling in each zone to this structural rent yields the zonal price deflators.[1]

These price deflators are then combined with census data on the number of dwelling units in specified rent and value intervals to generate model dwellings.

Table A-3 lists the model dwellings input to the Green Bay and South Bend simulations. The number of dwellings for the 1970 stock was limited both by the rate of growth of the market and by the solution program that is most efficient when there are fewer than 40 to 45 households. For Green Bay, there were 33 model dwellings, each representing approximately 1,180 actual units. South Bend's 40 model dwellings represented about 1,890 units.

A limitation of this methodology for measuring the start-of-decade distribution of housing services is that it assumes the price of housing services is constant throughout the area modeled. End-of-decade results of the model suggest the price varies by submarket. The benefits from removing this limitation could be tested by expanding on the simulations presented in this paper. The model has been applied to both the 1960-1970 and 1970-1980 decades for Green Bay and South Bend. The end-of-decade distribution of housing services from the first decade simulations, which permit price variation by submarket, could be substituted for the beginning-of-decade distribution in the latter simulations. Differences between these new simulation results and those in the body of this paper would show the effect of assuming a constant price.

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[1] de Leeuw and Struyk [4, pp. 62-66].

Table A-3

MODEL DWELLING UNITS, BY ZONE AND INITIAL LEVEL OF SERVICES: GREEN BAY AND SOUTH BEND

Green Bay

Zone	Service Level	Zone	Service Level	Zone	Service Level
1	46	2	109	3	113
1	66	2	121	3	122
1	78	2	133	3	132
1	89	2	144	3	141
1	100	2	156	3	153
1	115	2	178	3	165
1	131	2	228	3	183
1	154	3	45	3	214
1	239	3	70	3	296
2	63	3	83		
2	85	3	93		
2	97	3	104		

South Bend

Zone	Service Level	Zone	Service Level	Zone	Service Level
1	53	2	108	4	38
1	71	2	118	4	60
1	85	2	130	4	75
1	96	2	144	4	88
1	107	2	161	4	101
1	119	2	192	4	115
1	138	2	315	4	131
1	164	3	52	4	146
1	218	3	78	4	166
2	49	3	94	4	191
2	68	3	112	4	235
2	79	3	129	4	338
2	89	3	154		
	99		248		

Model Households

Once the start-of-decade housing stock has been introduced into the model, it must be supplied with an end-of-decade population that will determine the demand for housing. Projections of site-specific household populations, the allocation of those populations among the model's various household classifications, and 1980 incomes are treated differently for each site depending on the amount of information available.

Population Projection: Green Bay. Over the past few decades the Green Bay SMSA has experienced a rapid employment growth that has encouraged and supported a rapid growth in population. Between 1960 and 1975 alone the population grew by 34 percent,[1] and according to the Brown County Comprehensive Plan Update the latter half of the 1970s should show an additional 10-percent increase.

Increases in the number of households need not parallel population increases. National trends towards smaller households--especially elderly and single-person households--are bringing about faster growth in the number of households than in total population. However, a small market such as Green Bay with a large net inmigration might not be expected to follow national trends. Migrants would on the whole be younger, possibly have larger families, and therefore keep growth in the number of households closer to overall population growth. The problems in determining the interaction of these trends make it difficult to project 1980 household number and composition.

Racially, Brown County is a homogeneous community. There are only two model household types used to depict the population: (1) non-elderly families with head under 65 and (2) single persons and elderly families.

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[1]Market characteristics of both supply sites can be found in The Rand Corporation [19].

The classification acknowledges the difference in the proportion of income these groups devote to the consumption of housing services. We have information on the number of households in each type for both 1970 and 1975. The 1970 data were available directly from the decennial census; the 1975 data were derived from Rand's Survey of Tenants and Homeowners. The 1980 population distributions were determined by a linear projection of the number of households within each type. As reported in Table A-4, there was an increase of 19 percent in the number of non-elderly families over the decade and a decrease of 7 percent in the number of elderly and single-person households. Overall, the household population increased by 12 percent.

The resulting 1980 model household population is represented by 38 model households, each of which represents approximately 1,180 actual households. Their division by model type can be seen in Table A-5.

Population Projection: South Bend. Unlike Green Bay, South Bend has experienced a loss in employment, precipitated by a decline in what once was a dominant manufacturing industry. The selection of South Bend as an experimental site hinged on its slow central-city growth rate and its residentially segregated population. During the 1960s, the county was barely able to counteract net outmigration with a natural population increase of 2.7 percent. According to Rand survey data, population loss in the early 1970s amounted to 20,000 inhabitants or about 9 percent of its population.

South Bend's sizeable minority population distinguishes it from Green Bay. In 1975, approximately 9.5 percent of the county's households were black, which permitted a division of the county's households into four model types: (1) white non-elderly families, (2) white elderly and single-person households, (3) black non-elderly families, and (4) black elderly and single-person households. The census did not provide a breakdown for households by

Table A-4

1970-1980 GROWTH IN HOUSEHOLD POPULATION AND INCOME, GREEN BAY AND SOUTH BEND

Site/Type of Household	Population				Median Money Income			
	1970 Census	1975 Rand Survey	1980 Projection	Change (%)[a]	1970 Census	1975 Rand Survey	1980 Projection	Change (%)[a]
Green Bay								
White non-elderly	32,587	35,677	38,779	19	$10,992	$14,230	$20,050	82
White elderly single	10,973	10,582	10,183	-7	4,104	5,799	8,171	99
Black non-elderly	--	--	--	--	--	--	--	--
Black elderly single	--	--	--	--	--	--	--	--
Total	43,560	46,259	48,962	12	$ 9,332	$12,455	$17,549	88
South Bend								
White non-elderly	49,638	46,507	43,686	-6	$11,017	$13,701	$19,304	41
White elderly single	20,655	20,735	21,811	5	3,356	5,494	7,741	41
Black non-elderly	3,575	5,427	6,387	18	8,356	7,876	11,097	41
Black elderly single	1,881	1,667	2,351	41	2,977	5,676	7,997	41
Total	75,749	74,336	74,235	-2	$ 8,576	$10,677	$15,044	75

[a]For the household categories in South Bend, 1970 populations and income distributions were interpolated from census data on South Bend and on metropolitan Indiana racial distributions. These numbers played a minor role in making the 1980 projections because the accuracy of the interpolations was unknown. For this reason, the percentage changes in population (column 4) and in income (column 8) for the South Bend household types apply only to the 1975-1980 period.

The total household population and income figures reported for Green Bay came directly from the 1970 census, and their percentage changes (in columns 4 and 8) apply to the entire decade.

Table A-5

MODEL HOUSEHOLDS, BY HOUSEHOLD TYPE AND INCOME:
GREEN BAY AND SOUTH BEND

Green Bay

Type	Income	Type	Income	Type	Income
1	5,322	1	19,408	1	28,606
1	9,039	1	19,856	1	31,022
1	11,156	1	20,318	1	37,705
1	12,881	1	20,856	1	44,178
1	14,082	1	21,679	2	4,176
1	15,233	1	22,498	2	5,632
1	16,015	1	23,302	2	6,663
1	16,504	1	24,095	2	7,737
1	17,019	1	24,870	2	8,688
1	17,498	1	25,644	2	10,315
1	17,984	1	26,392	2	12,835
1	18,465	1	27,146	2	19,761
1	18,926	1	27,876		

South Bend

Type	Income	Type	Income	Type	Income
1	5,473	1	21,723	2	7,255
1	9,333	1	22,853	2	8,162
1	11,206	1	23,959	2	9,374
1	12,512	1	25,039	2	10,551
1	13,669	1	26,095	2	11,891
1	14,775	1	27,136	2	13,307
1	15,744	1	28,150	2	17,875
1	16,466	1	32,525	3	6,625
1	17,170	1	42,119	3	11,152
1	17,859	2	3,086	3	17,166
1	18,538	2	4,485	4	8,994
1	19,199	2	5,240		
1	19,858	2	5,988		
1	20,594	2	6,645		

NOTE: Household types are 1--white non-elderly families; 2--white elderly and single-person households; 3--black non-elderly families; and 4--black elderly and single-person households.
Income figures are estimates of permanent incomes in dollars per year.

race in 1970, which could have been used with Rand survey data to project 1980 household distributions.[1] The 1980 population projections in South Bend were therefore based on a number of assumptions about the growth of the non-white population and shifts in age composition and family size.

First a decision was made to restrict the total household population loss in the county to 2 percent. This was based on the 9-percent reduction in population noted by Rand for the 1970-1975 period, moderated somewhat by an independent projection of a 6.5 percent population increase for the decade,[2] and an observation from Rand's South Bend Housing Allowance Office that there has been a significant decrease in family size. Next we assumed that the number of South Bend's minority households would increase by 60 percent over the decade.[3] Then, we allowed for a shift in household composition from non-elderly families to the elderly and single-person households, based on national projections by age and race.[4]

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[1]The 1970 distribution of the county's population among household types was based on the distribution of households in Indiana's metropolitan areas.

[2]See Jerome P. Pickard, "U.S. Metropolitan Growth and Expansion, 1990-2000," Population Distribution and Policy, The Commission on Population Growth and the American Family, Washington, D.C., U.S. Government Printing Office, 1972. These slow growth population projections for St. Joseph County suggested a 6.5 percent decade growth.

[3]Census data suggest that there was a 30 percent growth in minority population in South Bend over the 1960s. Rand states in its Third Annual Report [19] that minority population between 1960 and 1975 has almost doubled, implying nearly a 50-percent growth in minority population in the first half of the 1970s. The 60-percent growth in household population may be somewhat conservative. Nonetheless, it indicates that minority households will increase their overall share of the population to 12 percent in 1980, compared to 7 percent in 1970. Moderate departures from this assumption would not change the model's representation of minorities due to the level of aggregation.

[4]Projections of national shifts in these household types for the 1970-1980 decade can be found in Struyk and Marshall [14, pp. A-9 - A-14.]

The actual population projections for 1980 appear in Table A-4. The sample consists of 39 model households, each of which represents approximately 1,900 actual households.

Income Projections

The most current information on income distributions by model household type was taken from a Rand survey reporting 1974 household incomes for each Supply Experiment site. These same income distributions were assigned to the projections on the 1980 model household population to yield a distribution of 1980 households with 1974 incomes. To obtain the 1979 income figures, each household's income was increased by 40.9 percent, based on national projections prepared by Data Resources, Inc. (DRI) on the growth in money income to the end of the decade.[1] As can be seen in Table A-4, income projections for Green Bay suggest an 88-percent increase in money income, while South Bend experiences only a 75-percent increase. Using DRI estimates of the Consumer Price Index in 1980, these numbers indicate a growth in real income over the decade of 18 percent in Green Bay and 5 percent in South Bend.

Factor Input Prices

Market projections for the decade also necessitate exogenous inputs of the average price per unit of capital (P_c) and operating (P_o) inputs to new housing. As in past applications, these data are derived from the capital and operating costs of new units insured under the FHA Section 203(b) program--a non-subsidized program for owner-occupied homes in one- to four-unit structures.

There are two limitations to the data: First, they are restricted only to single-family, owner-occupied units. Thus, an assumption has to be made that they accurately reflect costs for new rental units. This seems to be borne out by national price index data. Second, the characteristics of units covered

[1] See Struyk and Marshall [14, pp. A-1-A-7] and The Economic Report of the President, 1976 [17].

under the program vary from year to year. Conversion of these data to cost data for a "standard" unit was accomplished by a technique that adjusted FHA data to correspond to Bureau of Labor Statistics data measuring the value of owner-occupied units with a fixed set of characteristics at selected points in time.[1]

The procedure used to project prices was regression analysis. In South Bend, the regressions covered the period 1960-1973, relating FHA data for new unit capital costs to the CPI and FHA new home mortgage yields; operating costs were regressed on the Consumer Price Index.

The Wisconsin data used for Green Bay prediction equations were not available after 1970 because of the small number of new units insured under Section 203(b) in the state. A major shift in capital costs occurred in the late 1960s and it was thought that ending the regressions in 1970 would not capture the effect of that change on housing costs. After checking the effect of the shortened time period on regressions for national data on new units and on Wisconsin data for existing units, it was decided that the longer time period for capital costs was desirable and that national data could serve as a proxy for capital costs in Green Bay. National data, however, were inadequate for explaining region-specific operating costs. Thus, we used the shorter time period with Wisconsin data on new units to estimate operating costs. The regressions for both sites are indicated in Table A-6; Table A-7 shows the projected values of housing costs.

The decade change in prices reported show that capital costs had a projected increase of 97 percent in Green Bay and only 75 percent in South Bend. The change in the cost of maintaining South Bend's older housing stock outstripped operating costs in Green Bay by 126 to 115 percent.

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[1]See Raymond J. Struyk [11].

Table A-6

REGRESSION EQUATIONS USED TO PREDICT
OPERATING AND CAPITAL COSTS,
GREEN BAY AND SOUTH BEND

Site/Cost	Regression Results[a]						
	Constant	CPI	FHAMY	HZDUM	$\bar{R}^2$	SE	DW
Green Bay[b]							
P_c	-73.27 (-3.58)	1.19 (3.80)	6.89 (3.50)	5.56 (2.25)	0.98	2.42	2.79
P_o	-32.99 (-2.28	1.00 (7.18)	-- --	3.65 (1.50)	0.89	2.63	1.34
South Bend[c]							
P_c	-29.93 (-3.57)	0.81 (4.66)	5.90 (2.79)	-- --	0.96	3.72	1.98
P_o	-43.03 (-5.31)	1.08 (13.87)	-- --	-- --	0.94	4.20	1.91

[a]The Consumer Price Index (CPI) and the FHA new home mortgage yield (FHAMY) are both reported in The Economic Report of the President, 1976 [17]. Projections of the CPI are from May 1976 estimates from Data Resources, Inc. HZDUM is a dummy that denotes data non-comparability before and after 1965; for example, hazard insurance does not become a component of operating expense until 1965. The R^2, SE, and DW are standard regression statistics: residual sum of squares, standard error, and Durbin-Watson, respectively.

[b]The P_c equation for Green Bay is based on national capital costs for new units to permit three additional years of data; the FHA new-unit sample for Wisconsin was inadequate for 1971-1973.

[c]The P_c regression for South Bend is second-order autoregressive; P_o is first order autoregressive.

Table A-7

PREDICTED HOUSING COSTS FOR GREEN BAY AND SOUTH BEND, 1969-1979

	National Indexes[a]		Green Bay		South Bend	
	CPI	FHAMY	P_c	P_o	P_c	P_o
1969	109.800	8.19000	113.6	76.8	103.3	75.8
1970	116.300	9.05000	127.3	83.3	117.5	82.8
1971	121.300	7.78000	124.4	88.3	113.3	88.3
1972	125.300	7.53000	127.5	92.3	117.9	92.6
1973	133.100	8.08000	140.5	100.1	122.6	101.0
1974	147.700	9.47000	167.5	114.7	137.8	116.8
1975	161.200	9.22000	181.8	128.2	151.6	131.5
1976	170.500	9.00000	191.2	137.5	161.2	141.5
1977	179.800	9.00000	202.3	146.8	168.6	151.6
1978	189.200	9.00000	213.5	156.2	174.6	161.8
1979	198.200	9.00000	224.2	165.2	181.0	171.5
1969-1979 (percent change)			97	115	75	126

[a]The Consumer Price Index (CPI) and the FHA new home mortgage yield (FHAMY) are both reported in The Economic Report of the President, 1976 [17]. Projections of the CPI are from May 1976 estimates from Data Resources, Inc.; it was assumed that FHA home mortgage yield would hover at 9 percent to the end of the decade.

The theory underlying the model assumes that a single level of new construction cost per unit of service prevails throughout the ten-year period to which the model applies. Operating and capital costs are converted into indices and then summed to generate a market price of new construction. This price normally prevails across the moderate- and high-quality sectors of the market and is instrumental in determining rents. While averages of operating and capital costs were used in constructing indices for past simulations run for the 1960-1970 decade, averages of the rapidly increasing prices of the 1970s were too high. They tended to raise the overall cost of housing too much, in our judgment, relative to 1980 household incomes. We therefore selected the new construction price by setting the ratio of end-of-decade prices to average decade price in the 1970s equal to the same ratio in the 1960s. The resulting model prices indices in Green Bay were .80 for operating and 1.12 for capital costs. For South Bend, operating costs were .80 and capital costs, .95.

BIBLIOGRAPHY

1. Alesch, Daniel J. and Nancy O'Nell, "Rent Inflation Monitoring Report: Brown County, Wisconsin and St. Joseph County, Indiana, June 1976-December 1976," The Rand Corporation, Santa Monica, California, August 1977.

2. Carlson, David B. and John D. Heinberg, How Housing Allowances Work: Integrated Findings from the Experimental Housing Allowance Program, URI 21300, The Urban Institute, Washington, D.C., February 1978.

3. De Leeuw, Frank, Ann B. Schnare and Raymond J. Struyk, "Housing," in The Urban Predicament, William Gorham and Nathan Glazer (eds.), The Urban Institute, Washington, D.C., pp. 119-178.

4. De Leeuw, Frank and Raymond J. Struyk, The Web of Urban Housing: Analyzing Policy with Market Simulation Model, The Urban Institute, Washington, D.C., 1975.

5. Friedman, J. and D. H. Weinberg, "The Demand for Rental Housing: Evidence from an Experiment," Paper presented at the 47th annual conference of the Southern Economic Association, New Orleans, Louisiana, November 2-4, 1977.

6. Marshall, Sue A., The Urban Institute Housing Model: Application to South Bend, Indiana, Working Paper 216-26, The Urban Institute, Washington, D.C., June 1976.

7. Ozanne, Larry, Calculating Benefit/Cost Ratios with The Urban Institute Model, Working Paper 235-3, The Urban Institute, Washington, D.C., March 1977.

8. -----, Integrating the Supply Experiment and the Housing Market Model, Working Paper 216-18, The Urban Institute, Washington, D.C., July 1975.

9. -----, Simulations of Housing Allowance Policies for U.S. Cities: 1960-70, Working Paper 216-3, The Urban Institute, Washington, D.C., December 1974.

10. Rydell, C. Peter, Effects of Market Conditions on Prices and Profits of Rental Housing, P-6008, The Rand Corporation, Santa Monica, California, September 1977.

11. Sternleib, G., R. W. Burchell and D. Listokin, The Private Sector's Role in the Provision of Reasonably Priced Housing, Rutgers University Center for Urban Policy Research, New Brunswick, New Jersey, 1975.

12. Struyk, Raymond J., A Comparison of FHA and BLS Price Indices of Owner-Occupied Housing in Urban Areas, Working Paper 208-7, The Urban Institute, Washington, D.C., July 1972.

13. Struyk, Raymond J. and Sue A. Marshall, Estimating the Value of Housing Services with the Census User's Sample: Comparative Results for Five Areas, Working Paper 208-10, The Urban Institute, Washington, D.C., February 1973.

14. -----, Some Projections of Housing in Urban America in 1980, Working Paper 235-1, The Urban Institute, Washington, D.C., November 1976.

15. Struyk, Raymond, Sue A. Marshall and Larry Ozanne, Housing for the Urban Poor, The Urban Institute, Washington, D.C. (forthcoming, 1978).

16. Stucker, Daniel P., Rent Inflation in St. Joseph County, Indiana: 1974-77, WN-9734-HUD, The Rand Corporation, Santa Monica, California, September 1977.

17. The Economic Report of the President, 1976, U.S. Government Printing Office, Washington, D.C., February 1977, pp. 241, 260.

18. The Rand Corporation, Supply Experiment Seminar, "Two Years of Housing Allowances," held in Washington, D.C., September 28, 1977.

19. The Rand Corporation, Third Annual Report of the Housing Assistance Supply Experiment, R-2151-HUD, Santa Monica, California, February 1977.

20. Vanski, Jean., The Urban Institute Housing Model: Application to Green Bay, Wisconsin, Working Paper 216-27, The Urban Institute, Washington, D.C., June 1976.

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The Urban Institute's Housing Market Model has been well documented and used extensively since work began on its development in 1971. The following is a selected list of additional Urban Institute publications for those who are interested in learning more about the structure and applications of the model.

Theoretical and Technical Documentation

De Leeuw, Frank, Dennis Eisen, Sue Marshall and Raymond Struyk, Developmental Work on the Urban Institute Housing Model, Working Paper 208-21, February 1974.

De Leeuw, Frank, Sue A. Marshall and Raymond Struyk, Applications of the Urban Institute Model: Appraisal of Past Work and Initial Short-Period Application, Working Paper 221-8, August 1975.

Marshall, Sue, Manual for Operation of The Urban Institute Housing Model, Working Paper 235-2, March 1977.

General Policy Applications

Marshall, Sue and Raymond Struyk, Assessing the Long-Term Effects of the Section 8 Housing Program, Working Paper 235-2, January 1977.

Owen, Michael S. and Raymond Struyk, Market Effects of New Construction Subsidy-Housing Allowance Programs, Working Paper 221-4, April 1975.

Schnare, Ann and John W. Hartman, Simulating the Impact of Capital Cost Reductions with The Urban Institute Housing Model, Working Paper 231-2, February 1976.

Site-Specific Applications

de Leeuw, Frank and Raymond Struyk, assisted by Sue Marshall, Urban Institute Housing Model: Application to Austin, Texas, Working Paper 208-13, May 1973.

-----, Urban Institute Housing Model: Application to Durham, North Carolina, Working Paper 208-9, January 1973.

-----, Urban Institute Housing Model: Application to Pittsburgh, Pennsylvania, Working Paper 208-20, July 1973.

De Leeuw, Frank, Raymond Struyk and Sue Marshall, The Urban Institute Housing Model: Application to Chicago, Illinois, Working Paper 208-26, August, 1974.

-----, Urban Institute Housing Model: Application to Portland, Oregon, Working Paper 208-14, June 1973.

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Keys to Successful Housing Management, Morton L Isler, Robert Sadacca, and Margaret Drury, 1974, URI 53000, 70 pp., $1 95.

New Towns In-Town Why a Federal Program Failed Martha Derthick 1972, URI 70006, 102 pp., $2.95.

The Persistence of Racial Segregation in Housing, Perspectives on Housing series Ann B Schnare, 1978, URI 21600, 30 pp , $3.50.

Urban Residential Mobility Places, People, and Policy, Perspectives on Housing series, John L Goodman, 1978, URI 23100, 32 pp., $3.50.

Urban Homeownership, Raymond J. Struyk. 1976, URI 12400, 198 pp., $15.00.

The Web of Urban Housing: Analyzing Policy with Market Simulation Model Frank deLeeuw and Raymond J. Struyk 1975, URI 12900, hard cover, $10.00; URI 12700, paperback, $4 95, 231 pp.

PAPERS

A Comparison of the Experimental Housing Allowance Program and Great Britian's Rent Allowance Program John Trutko, Otto J. Hetzel, and A. David Yates, 1978 URI 22500, 52 pp $5 00.

The Development of A Prototype Equation for Public Housing Operating Expenses Robert Sadacca, Morton Isler, and Joan DeWitt, 1975, 111 pp $3.00.

Externalities, Segregation and Housing Prices, Ann Burnet Schnare 1974 URI 28000, 68 pp $2.50.

Homeownership Effects of Alternative Mortgage Instruments, James Follain and Raymond Struyk, 1977, URI 18900, 95 pp., $4.00.

Housing Fom the Existing Stock Comparative, Economic Analyses of Owner-Occupants and Landlords, Larry Ozanne and Raymond J. Struyk, 1976, URI 14900, 196 pp., $5.50.

The Housing Situation of Elderly Americans, Raymond J Struyk, 1976, URI 16300, 20 pp., $2.00

How Housing Allowances Work. Integrated Findings from the Experimental Housing Allowance Program, David B Carlson and John D Heinberg, 1978, URI 21300, 95 pp. $4 00

Incomes and Housing. Lessons from Experiments with Housing Allowances, Marc Bendick, Jr. and James P. Zais, 1978, URI 23900, 24 pp., $3.50.

Indicators of the Quality of U S Housing, Jeanne E. Goedert and John L. Goodman, 1977, URI 20200, 55 pp , $5.50

Management Performance in Public Housing, Robert Sadacca, Suzanne B. Loux, Morton L Isler, and Margaret J. Drury, 1974, URI 61000, 144 pp , $3.00

Modifying Section 8: Implications from Experiments with Housing Allowances, James P Zais Jeanne E Goedert, and John W Trutko, 1979, URI 24100, 61 pp , $4 50.

Program Housing Standards in the Experimental Housing Allowance Program. Analyzing Differences in the Demand and Supply Experiments, Joseph J. Valenza, 1977, URI 19300, 79 pp., $4 00.

Should Government Encourage Homeownership? Raymond Struyk, 1977 URI 18700, 67 pp $3.50.

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